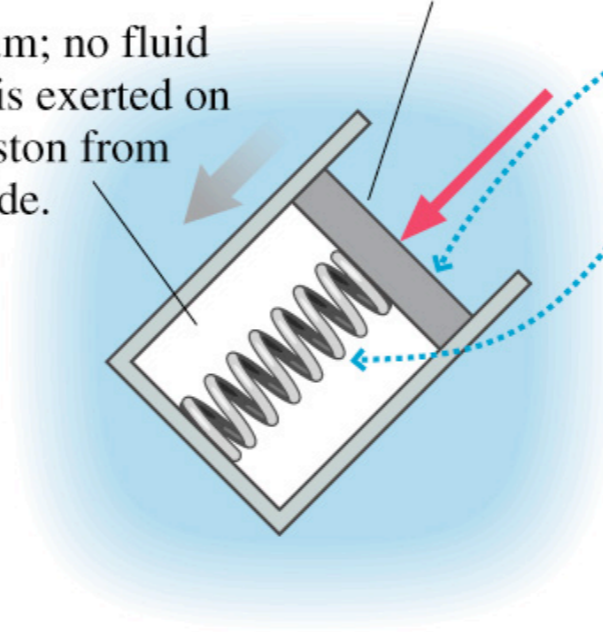


Figures for lecture 5

(a) Piston attached to spring

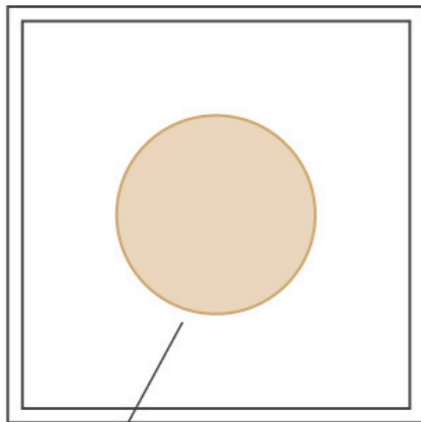
Vacuum; no fluid force is exerted on the piston from this side.



1. The fluid exerts force \vec{F} on a piston with surface area A .
2. The force compresses the spring. Because the spring constant k is known, we can use the spring's compression to find F .
3. Because A is known, we can find the pressure from $p = F/A$.

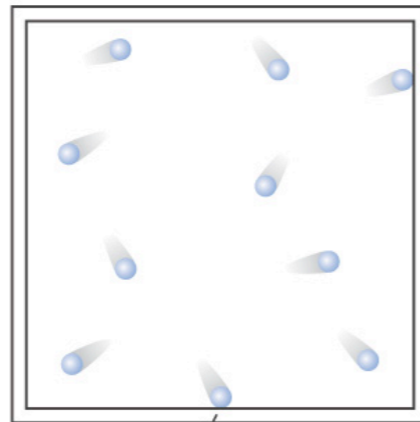
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Liquid



Nothing is touching the wall. There is no pressure.

Gas



Molecules are colliding with the wall. There is pressure.

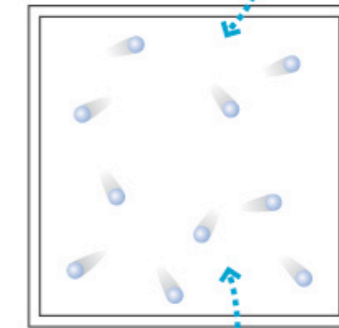
Liquid



As gravity pulls down, the liquid exerts a force on the bottom and sides of its container.

Slightly less density and pressure at the top

Gas



Slightly more density and pressure at the bottom

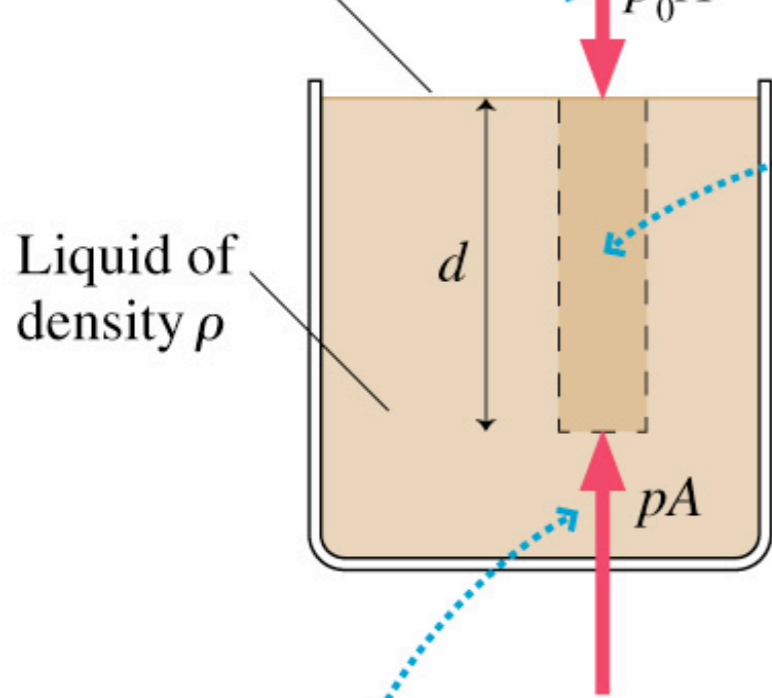
Gravity has little effect on the pressure of the gas.

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Whatever is above the liquid pushes down on the top of the cylinder.

Pressure p_0 at the surface



Liquid of density ρ

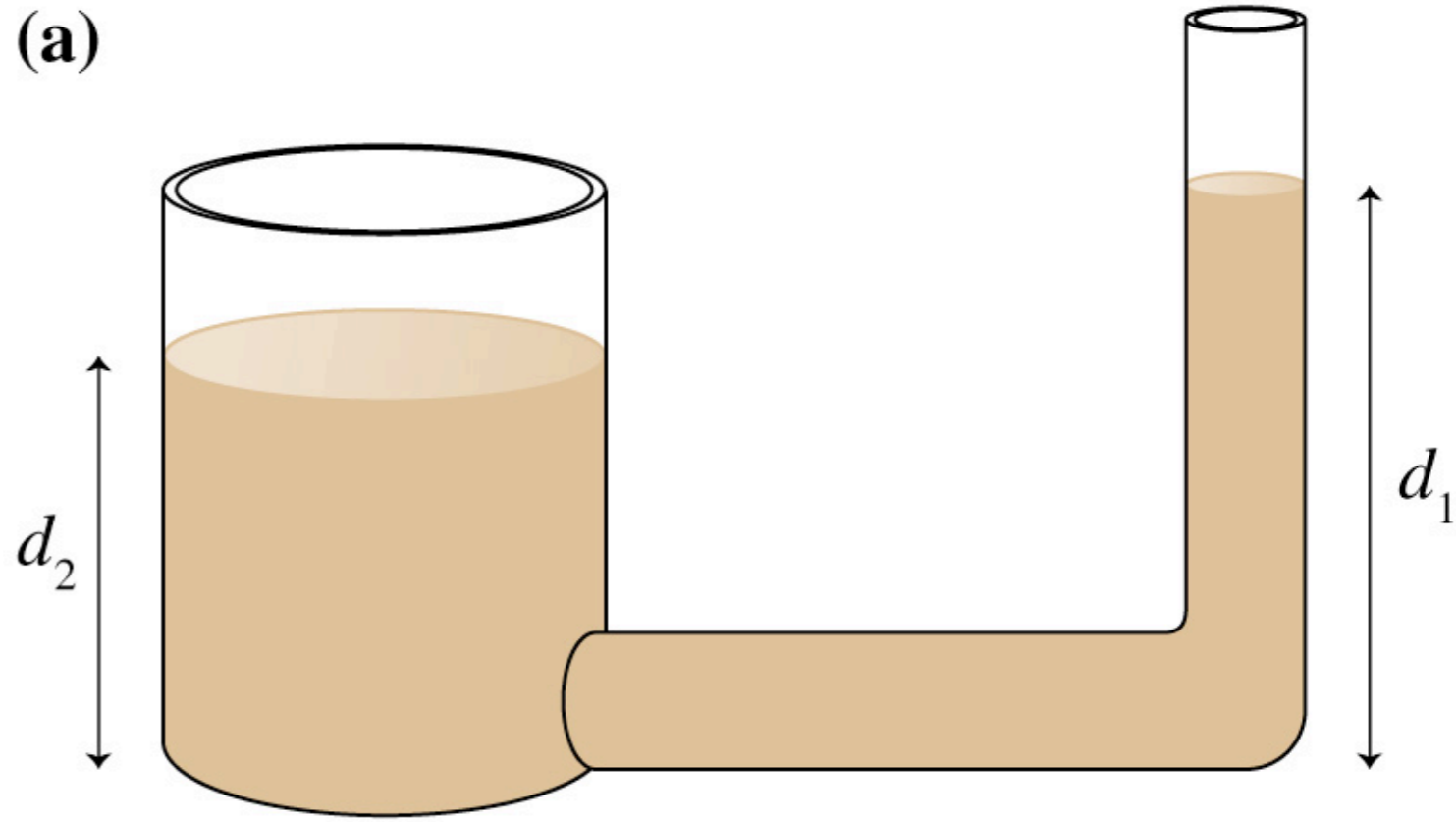
d

$p A$

This cylinder of liquid (depth d , cross-section area A) is in static equilibrium.

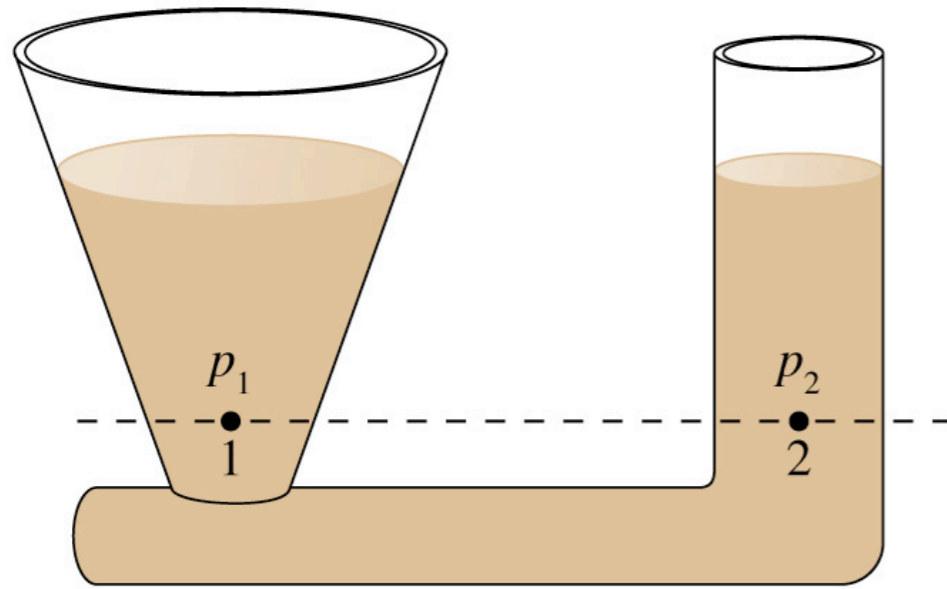
The liquid beneath the cylinder pushes up on the cylinder. The pressure at depth d is p .

(a)



Is this possible?

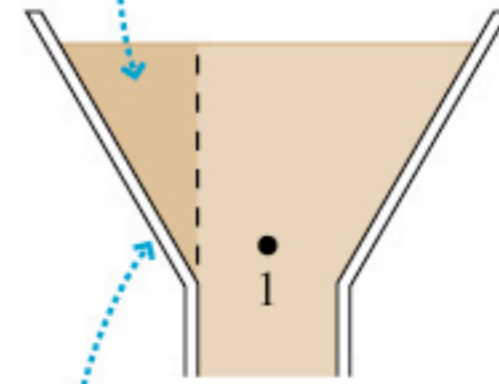
(b)



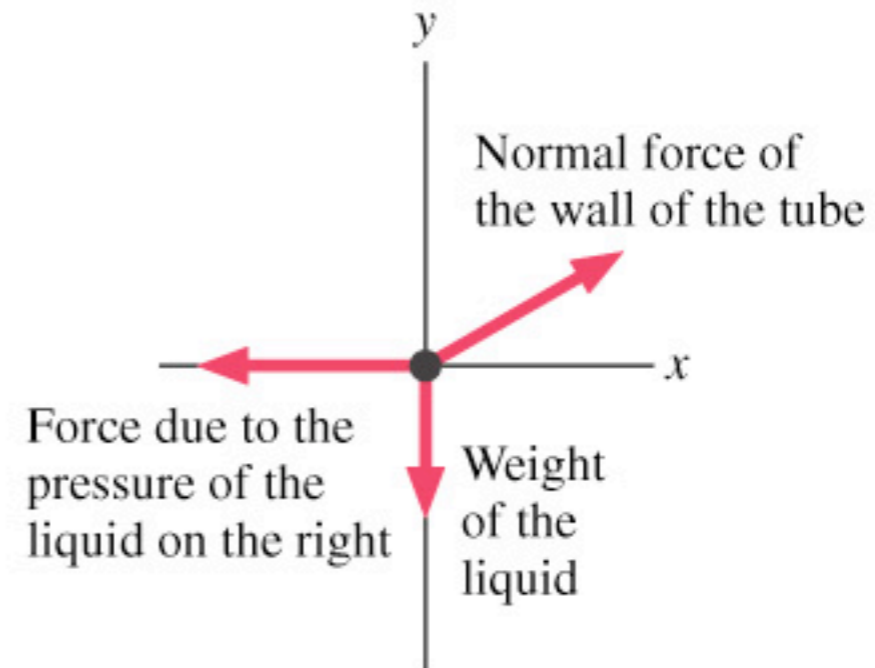
Is $p_1 > p_2$?

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Focus on this piece of the liquid.



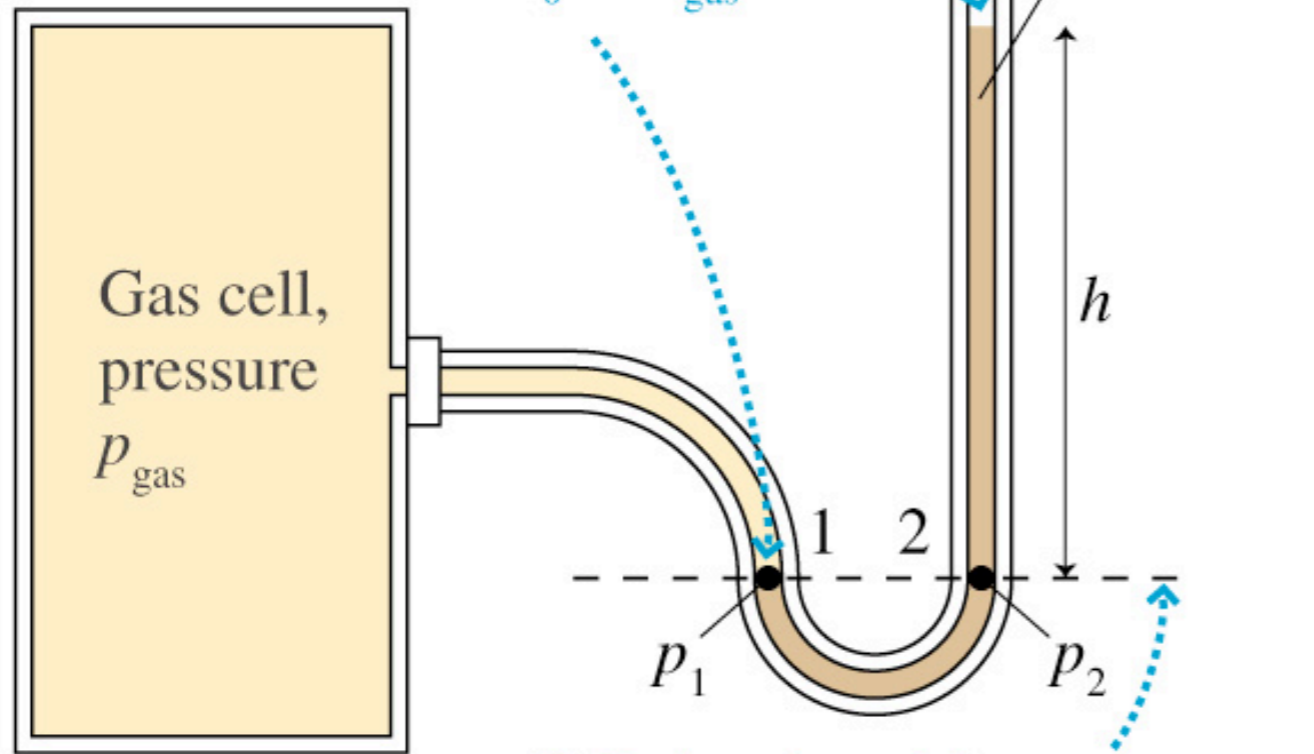
The wall of the tube supports the "extra" liquid.



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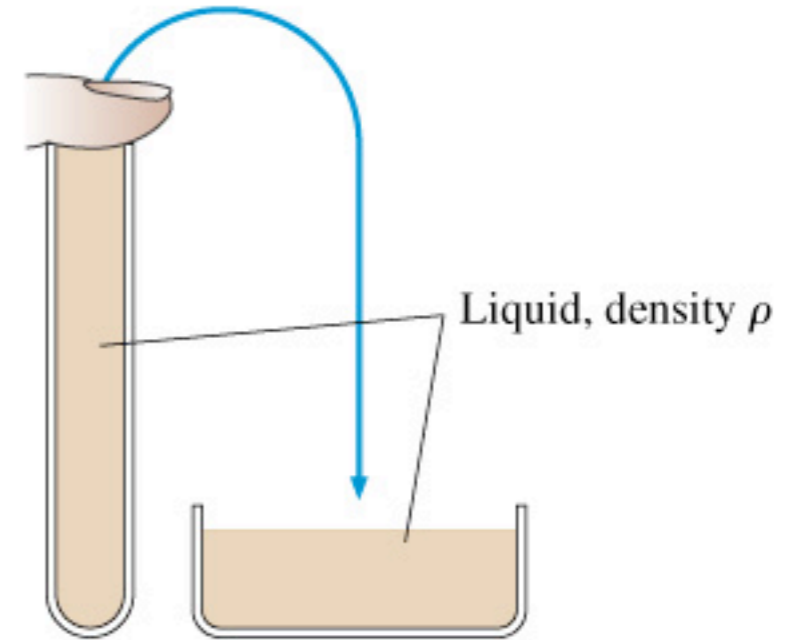
1 Draw a picture.

2 This is an open surface, so $p_0 = 1 \text{ atm}$. This is a surface covered by a gas, so $p_0 = p_{\text{gas}}$.

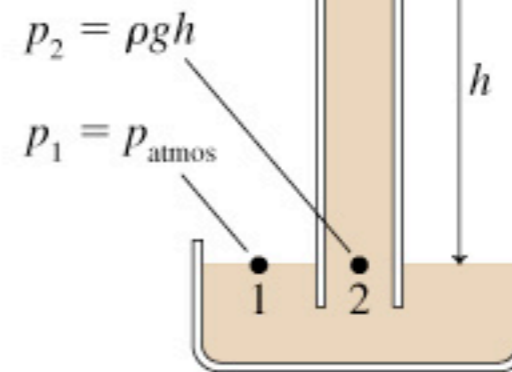


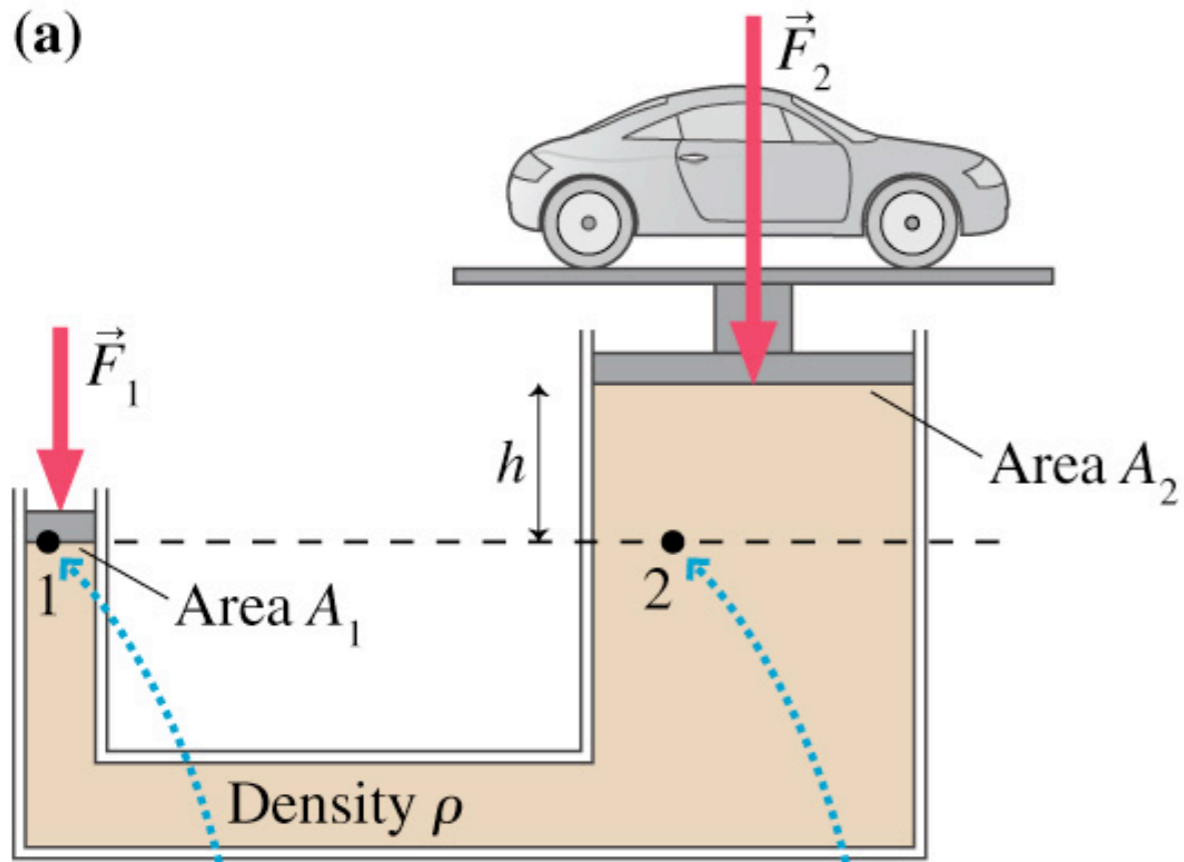
3 Points 1 and 2 are on a horizontal line, so $p_1 = p_2$.

(a) Seal and invert tube.



(b) Vacuum (zero pressure)

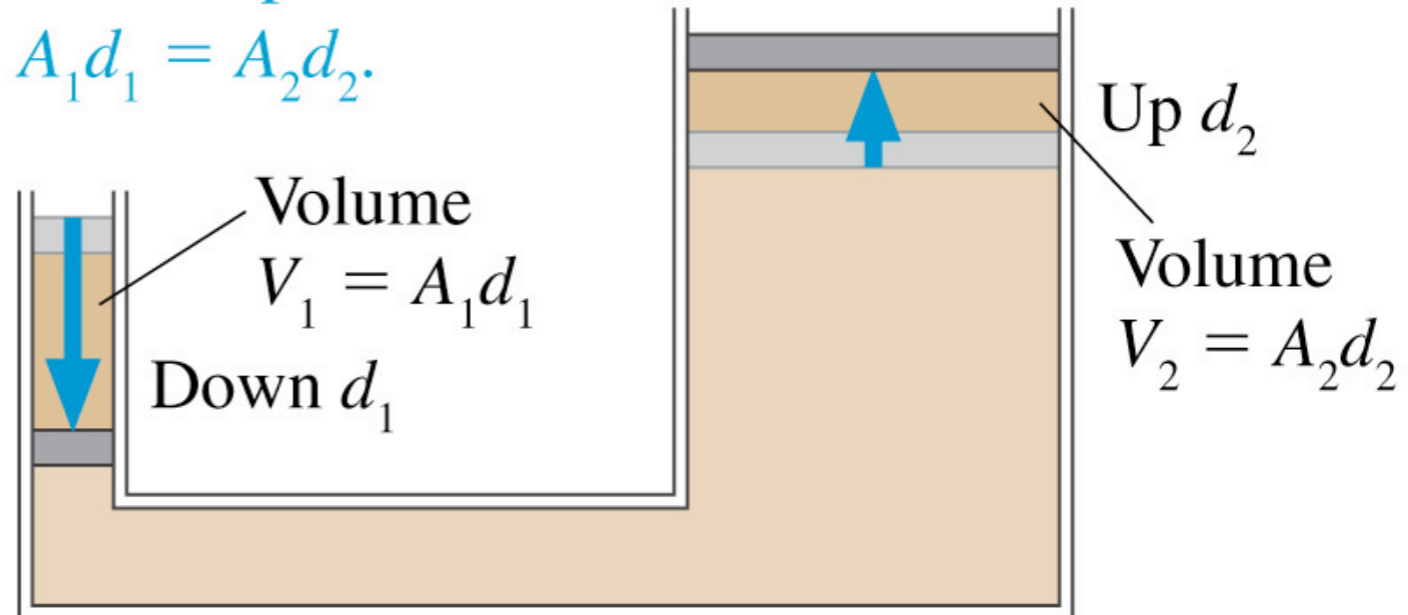




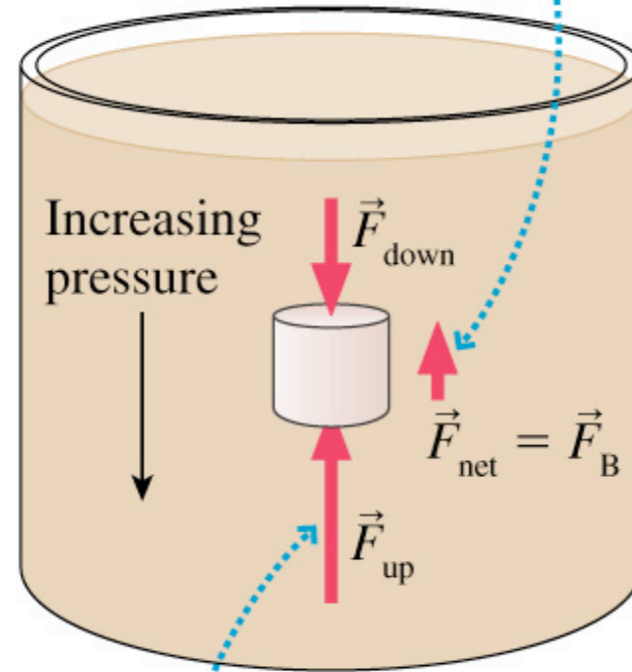
Pressure p_1 is due to atmospheric pressure p_0 plus pressure F_1/A_1 , due to \vec{F}_1 .

Pressure p_2 is p_0 plus F_2/A_2 plus ρgh from the liquid column of height h .

(b)
 Because the fluid is incompressible,
 $A_1 d_1 = A_2 d_2$.



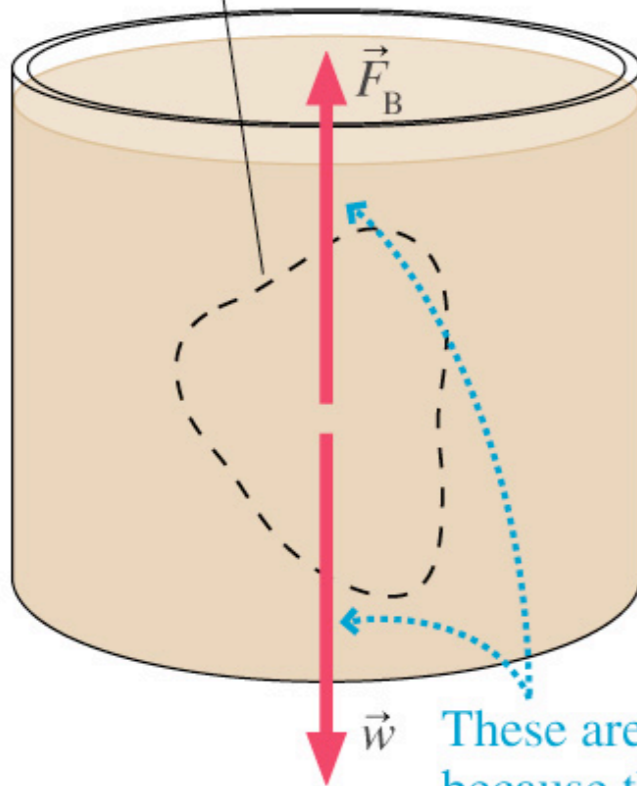
The net force of the fluid on the cylinder is the buoyant force \vec{F}_B .



$F_{up} > F_{down}$ because the pressure is greater at the bottom. Hence the fluid exerts a net upward force.

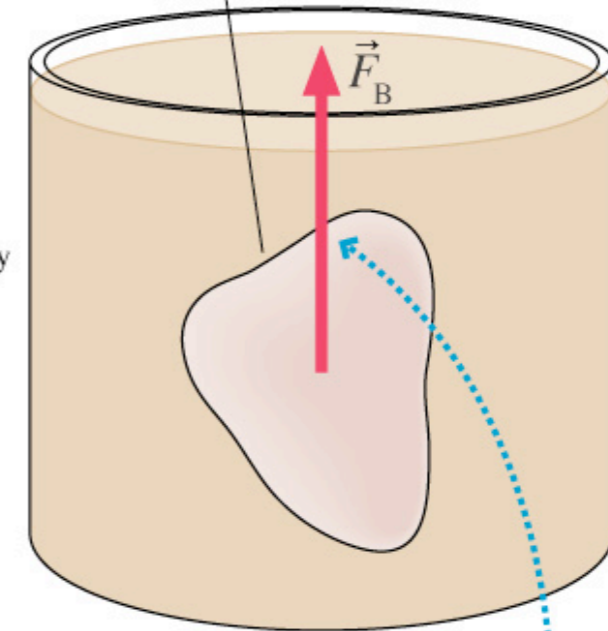
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(a) Imaginary boundary around a parcel of fluid



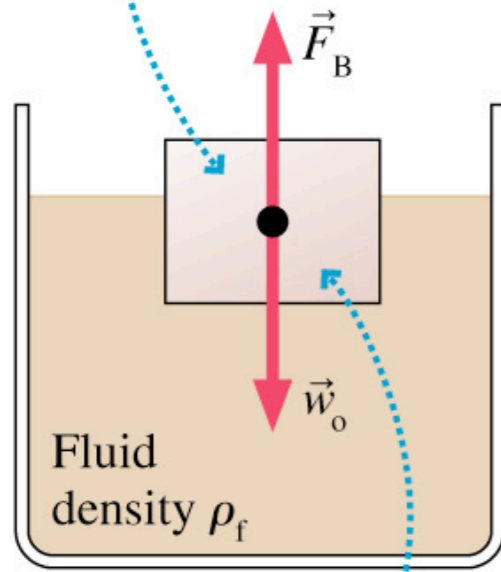
These are equal because the parcel is in static equilibrium.

(b) Real object with same size and shape as the parcel of fluid



The buoyant force on the object is the same as on the parcel of fluid because the surrounding fluid has not changed.

An object of density ρ_o and volume V_o is floating on a fluid of density ρ_f .



The submerged volume of the object is equal to the volume V_f of displaced fluid.

