In this course, the terms fluid and liquid are synonymous.

Fluid statics is the study of fluids at rest.
Pressure

Definition:

\[ \text{pressure} = \frac{\text{force}}{\text{area}} \]

In symbols:

\[ p = \frac{F}{A} \]

Units: N/m\(^2\)

Note: 1 N/m\(^2\) is also called a pascal (Pa)
We have now used the letter “p” to represent at least three different quantities:

- momentum $\mathbf{p} = m\mathbf{v}$
- power $P = \frac{W}{t}$
- pressure $p = \frac{F}{A}$

Don’t just guess at equations that have a “p” in them – you have a two in three chance of guessing wrong!
Be careful with symbols.

We are using a lowercase English letter “p” to represent pressure:

\[ p \]

We use the lowercase Greek letter “\( \rho \) (rho)” to represent density:

\[ \rho \]

They are not the same. Get out of the habit of saying “p” when you mean “\( \rho \)”. 
Pressure in a static fluid

\[ p = p_{\text{top}} + \rho gh \]
Clicker question 1.

In which container is the pressure greatest at the depth $h$ shown?

A. Container A
B. Container B
C. The pressure is the same at depth $h$ in both containers.
The buoyant force

An object submerged (either partially or wholly) experiences an upward force called the **buoyant force**.

The buoyant force is always directed vertically upward.
Archimedes’ principle

The **magnitude** of the buoyant force is equal to the **weight** of the liquid **displaced** by the object.

\[ F_B = \text{weight of displaced liquid} = m_1 g \]
Density:

\[ \rho = \frac{m}{V} \]

We can rearrange this to get an equation for \( m \):

\[ m = \rho V \]
Archimedes’ principle

The magnitude of the buoyant force is equal to the weight of the liquid displaced by the object.

\[ F_B = \text{weight of displaced liquid} \]
\[ = m_1 g \]
\[ = \rho_l V_{\text{disp}} g \]
Example 2.
Clicker question 2.

A ball which floats in water is placed in one of two identical cups. The cups are then filled with water so that the water level in both cups is the same. Which cup (+ contents) weighs more?

A. Cup with the ball  
B. Cup without the ball  
C. They have the same weight
Fluid Dynamics
Fluid dynamics
The continuity equation

(Also called the conservation of mass equation.)

Consider a fluid (such as water) moving through a channel (e.g. pipes, a river bed) that changes size.

The speed of the fluid at two points in the flow is related by the continuity equation:

\[ v_1 A_1 = v_2 A_2 \]
Clicker question 3.

The sketch shows an aerial view of a river. At which point along the river would the water be flowing fastest?
Bernoulli’s equation

Consider a moving fluid.

The pressure and speed at any two points in the fluid are related by Bernoulli’s equation:

\[ p_1 + \frac{1}{2} \rho v_1^2 + \rho g y_1 = p_2 + \frac{1}{2} \rho v_2^2 + \rho g y_2 \]