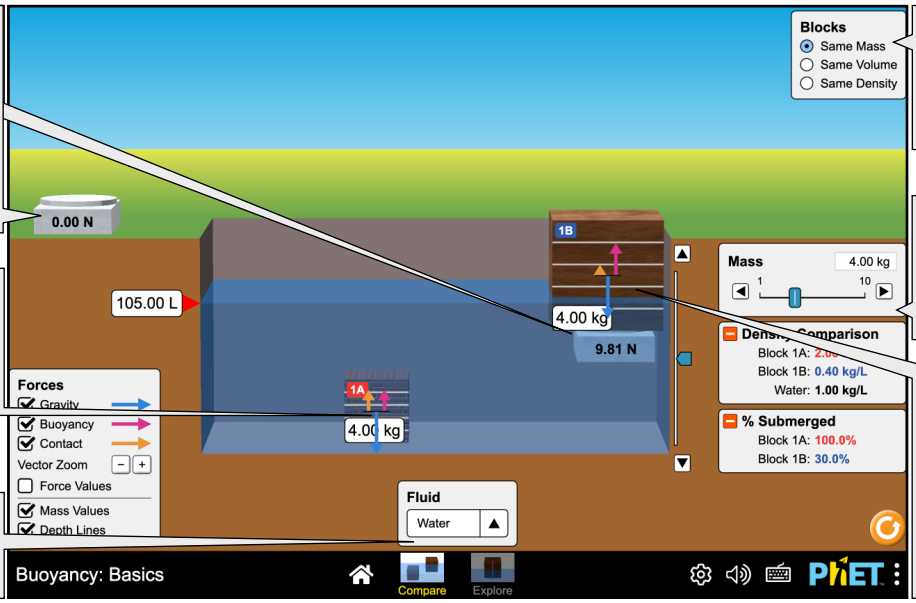
Buoyancy: Basics

Compare Screen

Compare the buoyant behavior of two blocks that can have the same mass, volume, or density when they are placed in a pool of different fluids.



MEASURE the block's weigh out and inside the pool. The scales are movable.

OBSERVE and **ANALYZE** the forces

CHANGE the fluid in the pool

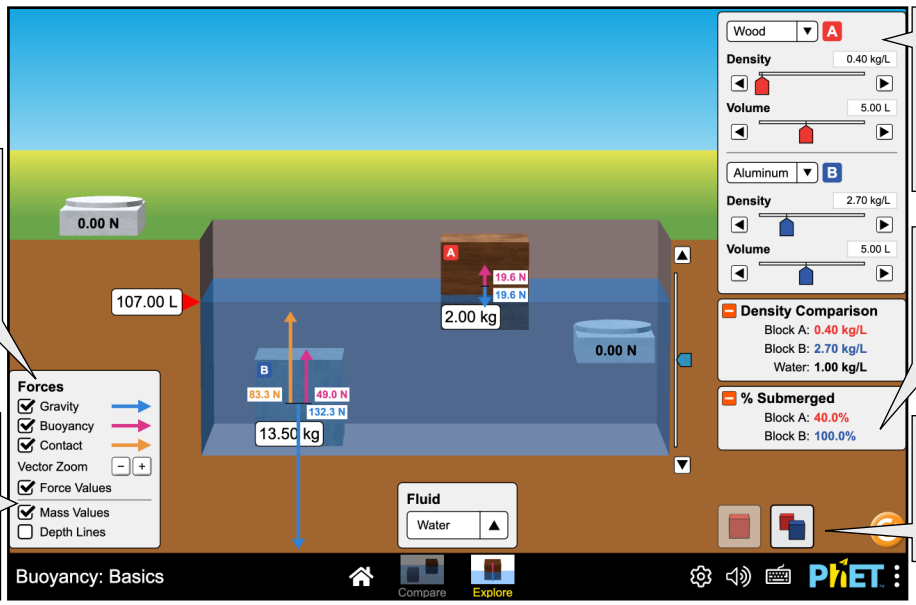
SELECT the scenario to compare

MODIFY the value of the shared parameter

DESCRIBE how a block floats/ sinks using the depth lines reference

Explore Screen

Interact with blocks of different materials. Modify their density and volume and explore how it sinks/floats in a pool with different fluids. Analyze the changes in the forces and their relationship with the buoyant behavior of the block.



ACTIVATE the vectors of the forces and adjust their zoom level

PERFORM deeper analysis by activating the values

MODIFY the block's material, density and volume

ANALYZE the % submerged of each block

ADD a second block for comparison

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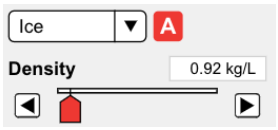
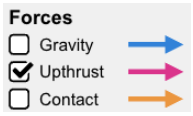
Insights into Student Use

- Students do not need to be told to put the block in the water; it is often their first move.
- Comparing two blocks at a time helps students notice the important ideas about buoyancy. For that reason, the simulation begins with the Compare screen.
- Students naturally want to measure the weight of the blocks on the scale outside and inside the pool, and they conclude where the block weighs less. In scenarios where the block is floating above the scale (as pictured on the right), some students push the block down onto the scale in attempt to measure its weight. However, the resulting reading will be inaccurate.
- Students learn that density is what determines whether an object sinks or floats. The "Same Density" scenario in the Compare screen is especially useful for students to achieve that conclusion.

Complex Controls

- Sudden changes in the aspect ratio of the simulation can result in blocks being shifted around. In extreme situations, blocks can be lost off-screen, but they can be restored with the Reset All button.
- In the Compare Screen, once the user modifies the mass/volume/density of the blocks, the color of the blocks changes to a gradient blue/yellow color that depends on its density (light color for low-density values, dark for high-density values). Returning to the initial density values with the sliders doesn't return the blocks to wood/brick, but they can be restored with the Reset All button.
- In the Explore screen, there are two ways to change the density of the blocks. The material can be selected from the drop-down menu or by using the Density slider (pictured right). When using the latter, the block's material will automatically change to "Custom" and its color will become shades of gray. Some students may need additional support to notice this change.

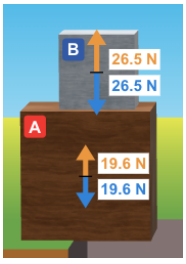


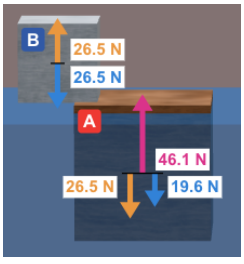


- To change "buoyancy" for "upthrust" use the locale sim in English (United Kingdom) that correspond to this link, or by adding ?locale=en_GB at the end of the sim's URL.

Model Simplifications

- When in the pool, the scale is not affected by the hydrostatic pressure of the fluid.
- The highest density fluid is mercury (13.59 kg/L), which is greater than the maximum possible density of the block (10 kg/L). We chose not to include blocks with higher densities because abrupt changes in fluid density could lead to blocks being ejected pool and being lost.
- The Contact Force is not intended to be analyzed while the block is user-controlled, either directly or indirectly. This force only makes sense when the block is at rest.
- The simulation is centered on the behavior of the blocks in the pool to analyze the buoyant force and the equilibrium of forces. For this reason, the Contact Force generated by one block on another is only considered inside of the pool. For example, in the right scenario, we observe a 26.5N downward contact force on Block A generated by Block B) when it is in the pool. When the blocks are on the ground, this contact force is not present (left scenario).





- The model is limited to vertical forces, without considering torque. Blocks cannot rotate.

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- See the Model Documentation for more information about the simulation model.

Customization Options

Query parameters allow for customization of the simulation, and can be added by appending a '?' to the sim URL, and separating each query parameter with a '&'. The general URL pattern is:
`…html?queryParameter1&queryParameter2&queryParameter3`

For example, in Buoyancy: Basis, if you only want to use the second screen (`screens=2`), and set the gravitational acceleration to 10 m/s² (`gEarth=10`) use:
https://phet.colorado.edu/sims/html/buoyancy-basics/latest/buoyancy-basics_all.html?screens=2&gEarth=10

To run this in Spanish (`locale=es`), the URL would become:
https://phet.colorado.edu/sims/html/buoyancy-basics/latest/buoyancy-basics_all.html?screens=2&gEarth=10&locale=es

⚙ Indicates this customization can be accessed from the Preferences menu within the simulation.

Query Parameter and Description	Examples
⚙ `volumeUnits` - specifies units for volume, `decimetersCubed` or `liters` (default).	`volumeUnits=decimetersCubed`
⚙ `percentSubmergedVisible` - when `true` the '% Submerged' readouts are visible in the simulation.	`percentSubmergedVisible=false`
`gEarth` - sets the value of Earth's gravitational acceleration between `9` and `10` m/s². Default is `9.8`.	`gEarth=10`
`screens` - launches the screens listed after the '='. For more information, visit the Help Center.	`screens=1` `screens=2,1`
`initialScreen` - opens the sim directly to the specified screen, bypassing the home screen.	`initialScreen=1` `initialScreen=2`
⚙ `audio` - if muted, audio is muted by default. If disabled, all audio is permanently turned off.	`audio=muted` `audio=disabled`
⚙ `locale` - specify the language of the simulation using ISO 639-1 codes. Available locales are listed at the simulation page on the Translations tab. Note: this only works if the simulation URL ends in "_all.html".	`locale=es` (Spanish) `locale=fr` (French)
`supportsPanAndZoom` - when `true`, enables panning and zooming of the simulation using pinch-to-zoom or browser zoom controls.	`supportsPanAndZoom=false`
`allowLinks` - when `false`, disables links that take students to an external URL. Default is `true`.	`allowLinks=false`

Suggestions for Use

Sample Challenge Prompts

- Determine all the variables that affect if a block sinks or floats in a fluid.
- Find the crucial condition to predict if an object is going to float or sink in a fluid.
- Describe the relationship between the block's percentage submerged, the density of the block, and the fluid in the pool.

- Design an experiment to describe the behavior of the apparent weight of a block in terms of its percentage submerged.
- Identify the variables that affect the buoyant force.
- Describe in terms of the forces the system in a static equilibrium of one block submerged, one block floating, and one block floating with another block on top of it.

See all published activities for Buoyancy: Basics here.
For more tips on using PhET sims with your students, see Tips for Using PhET.

López & Rouinfar, July 2024