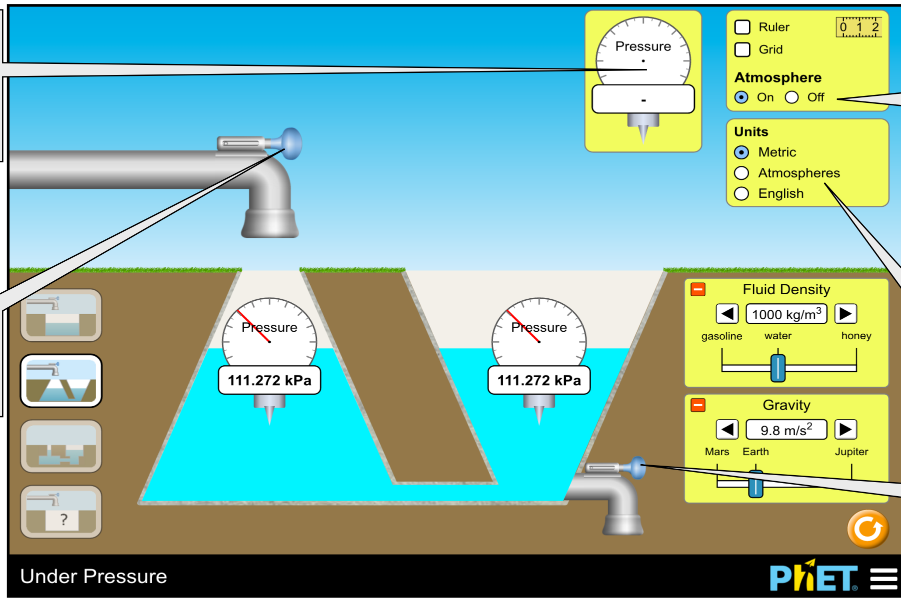
PhET Tips for Teachers — Under Pressure

The ***Under Pressure*** simulation allows students to explore pressure under and above water, as change fluid density, gravity, container shapes, and volume is varied.

MEASURE the pressure at up to four locations

ADD fluid to the system



EXPLORE the system with or without the presence of atmospheric pressure

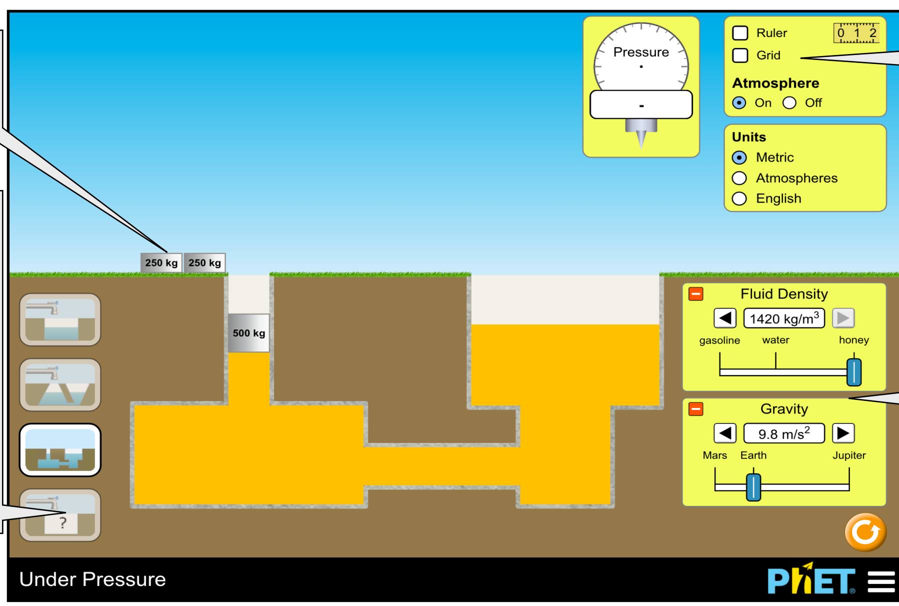
CHOOSE the desired units of pressure

DRAIN fluid from the system

PLACE masses onto the fluid

INVESTIGATE fluids with an unknown density or planets with unknown gravity

- Mystery Fluid
- Mystery Planet



MEASURE the height using a ruler or grid

ADJUST the fluid density and gravity

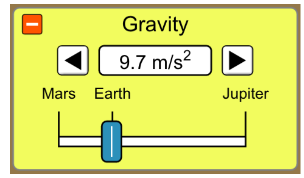
Rouinfar, August 2023

Model Simplifications

- The simulation displays a thin slice of an underground basin with fluid in it, where the top of the basin is at sea level.
- The pressure gauges are very sensitive, so you may expect some variations in answers.

Insights into Student Use

- Because the gravity slider has few tick marks, it is easy for a student to think they have set the slider to Earth, but the value may not be exactly 9.8 m/s². The gravity can be adjusted in 0.1 m/s² increments using the buttons on either side of the readout.



Suggestions for Use

Sample Challenge Prompts

- Design an experiment to determine the factors influence the pressure in the tank.
- Predict the pressure reading when the gauge is placed at 0m.
- What effect does the atmosphere have on the pressure at the bottom of the tank? How would your observations change if the tank was located at the top of a mountain?
- Predict how the pressure in the tank will change if a mass is placed in the tank. How does the 250 kg mass compare to the 500 kg mass?
- Develop a method to determine the unknown density of the mystery fluids.

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 Under Pressure, if you want to run the sim in Spanish `(locale=es)` and disable external links `(allowLinks=false)` use:
https://phet.colorado.edu/sims/html/under-pressure/latest/under-pressure_all.html?locale=es&allowLinks=false

Query Parameter and Description	Example Links
`locale` - specify the language of the simulation using ISO 639-1 codes. Available locales can be found on 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)
`allowLinks` - when `false`, disables links that take students to an external URL. Default is `true`.	`allowLinks=false`

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

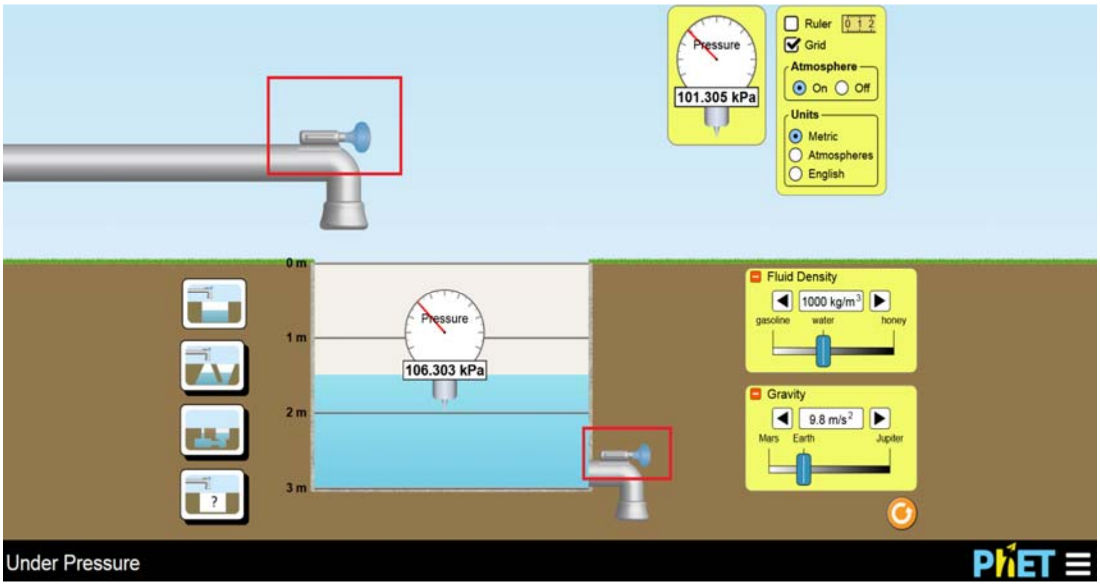
Rouinfar, August 2023

Simulation Activity – Fluid pressure

Simulation Link: https://bit.ly/fluidpressuresim

Experiment 1

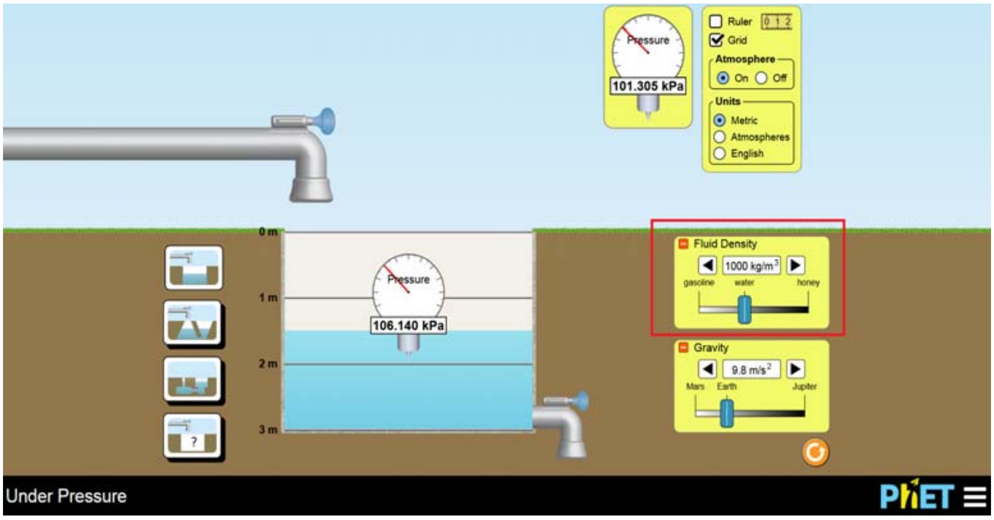
1. Enable **Grid**
2. Drag the pressure gauge at the line of **2m** (shown as below)



3. Try to open the water valve at the top. Observe the change of the pressure.
4. Try to open the water valve at the bottom. Observe the change of the pressure.
5. Describe your observation and explain why.

Experiment 2

1. Observe the change of pressure when you increase and decrease the **fluid density**.



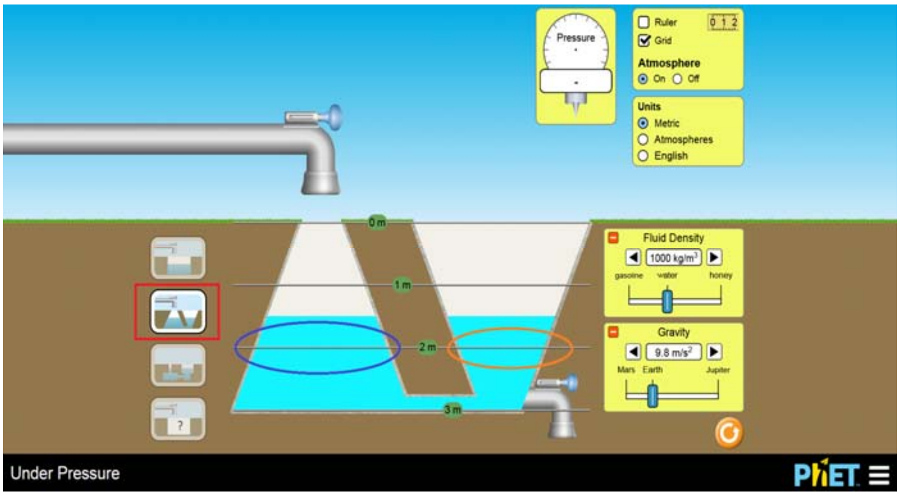
2. Describe your observation and explain why.

Experiment 3

1. Observe the change of pressure when you increase and decrease the "**Gravity**".
2. Describe your observation and explain why.

Experiment 4

1. Switch to the **second** scenario (red) which gives you another shape



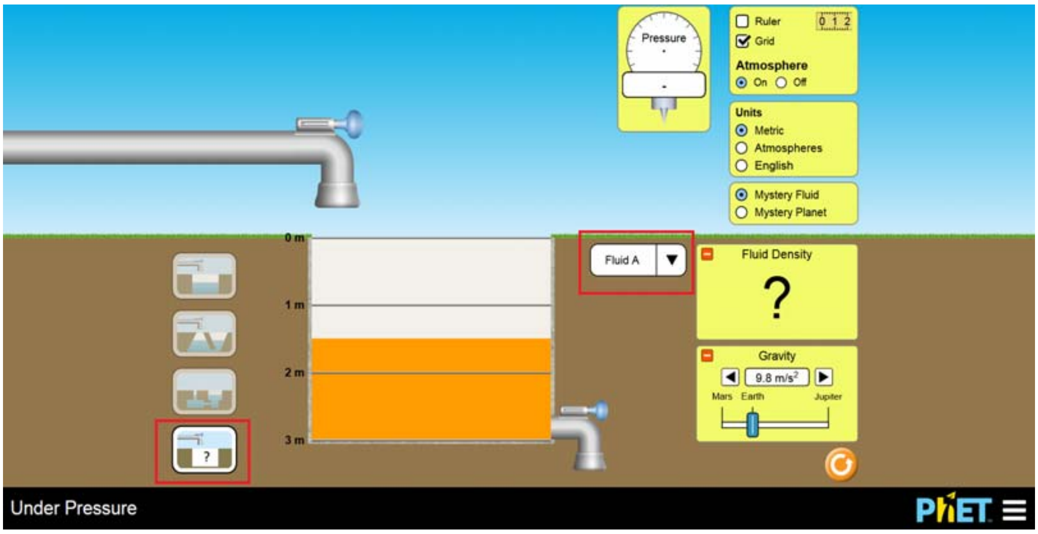
2. Drag the pressure gauge at the line of **2m** on the left (blue)
3. Drag another pressure gauge at the line of **2m** on the right (orange)
4. You can also try to move the pressure gauge horizontally along the line of 2m
5. How did the readings change? Explain why.

Experiment 5

1. Drag the pressure gauge out from the liquid.
2. Describe the change of pressure when you move the pressure gauge **vertically** in the **air**. Explain why.

3. How is this different when you do the same inside the liquid? Why?

Investigation Challenge 1



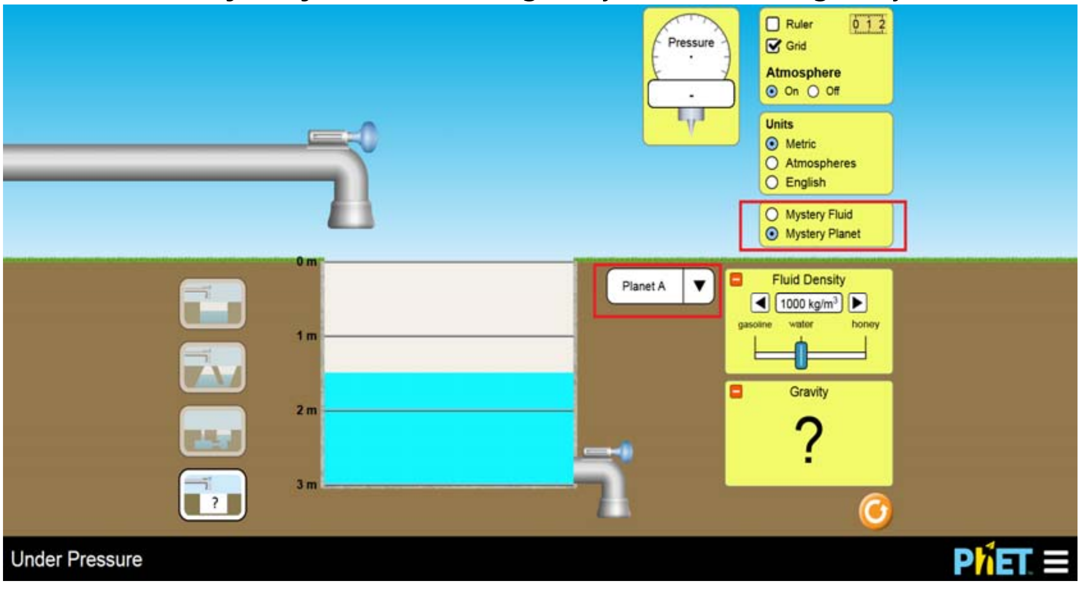
1. Switch to the **fourth** scenario (red) which gives you unknown density (Fluid A)
2. Suggest and describe a method to estimate the density of the Fluid A.

3. Show your calculation and the answer below.

4. Switch it to Fluid B and do the same. What is the density of Fluid B?

Investigation Challenge 2

1. Switch to the **Mystery Planet** which gives you unknown "gravity" (Planet A)



2. Suggest and describe a method to estimate the gravitational field strength of the Planet A.

3. Show your calculation and the answer below.

4. Switch it to Planet **C** and do the same. What is the gravitational field strength of Fluid C?

Name: ______________________________

Period: _____

Date: ___ / ___ / ___

Static Fluid Pressure and Fluid Flow

Students Will

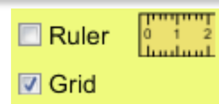
- ☐ Apply the concept of static fluid pressure to real world problems
- ☐ Investigate concepts of fluid flow

Notes for today:

- Use Pascals for your unit of pressure. Remember, $[Pa] = [\frac{N}{m^2}]$
- For all of your pressures today, use four significant figures for your answers. For example, if the pressure meter gives you 101.325 kPa you can write that as 101,300 Pa.

Part 1: Atmospheric Pressure

Setup



- In the top right hand corner, select the grid option for the simulation.
- Using the sliding knob, fill the pool so that there the water is 3 meters deep
- Make sure that the acceleration due to gravity is equal to 9.8 m/s^2

Click the pressure meter to control it. Drag the pressure meter to ground level and determine the pressure at the ground. Record this value in the space below.

P_{atm} = ____________________ Pa

This value is the **atmospheric pressure**; because that is the pressure you feel when one atmosphere is on top of you.

Where do you think the atmospheric pressure is the least?

☐ Denver, CO (1609 m above sea level)

☐ Ocean City, NJ (0 meters above sea level)

☐ Death Valley, CA (86 meters below sea level)

☐ Hillsborough, NJ (45 meters above sea level)

Explain your response: ____

____

____

____

Part II: Gauge pressure, Absolute Pressure, and atms

Now let's go under water, where the pressure is different. The pressure-meter on the simulation measures **absolute pressure**, the actual pressure that is occurring. Depending on our situation it may be beneficial to represent the pressure in a different way. **Gauge pressure** ignores atmospheric pressure and only takes into account the fluid. **Atmospheres** or **atms** represent the "number of atmospheres" you are experiencing. Use the simulation and your brain to fill in the table below.

	Gauge Pressure	Absolute Pressure	Atmospheres
1.0 meter below the surface			
2.0 meters below the surface			
3.0 meters below the surface			

Part III: Calculating Pressure

To determine the absolute pressure of a static (unmoving) fluid, we can apply the following concept.

$$P = P_0 + \rho g h$$

Summarize this formula in words. ____

____

____

For this next part you'll have to decide what type of person you are. Do you want to jump into a pool full of honey or gasoline?

☐ Gasoline (ρ_g = 700 kg/m^3) ☐ Honey (ρ_H = 1420 kg/m^3)

Justify your response: ____

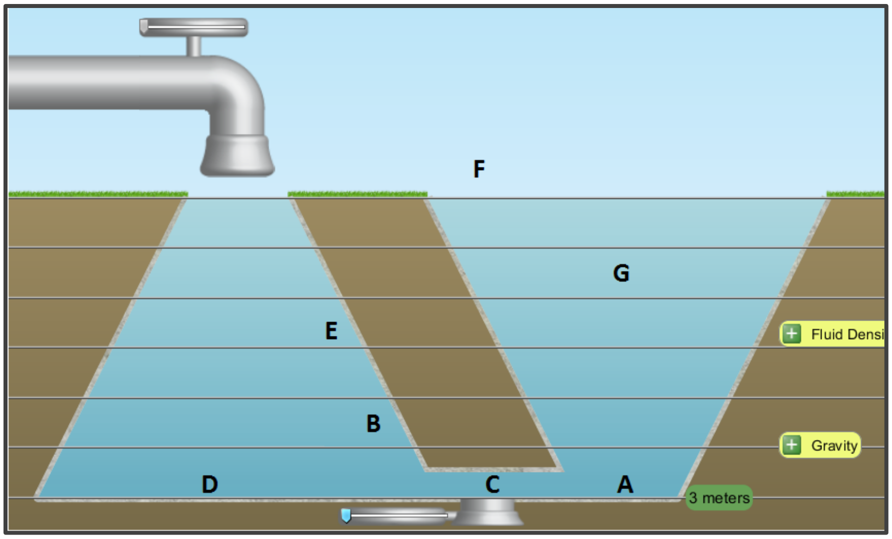
____

____

So now that you've made your decision, predict the gauge pressure 3.0 meters below the surface of your fluid. Show your work in the space below.

Check your answer by using the simulation.

Part IV: Pressure at different depths



Rank the following points on the diagram above from least pressure to greatest pressure. If any points have the same pressure, give them the same ranking.

____ A ____ B ____ C ____ D ____ E ____ F ____ G

Justify your response: ____

____

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