SIEMENS STEM DAY | Science Technology Engineering Math

GRADES 9–12

SIEMENS STEM DAY ACTIVITY

MAKE IT MOVE

OBJECTIVES

Students will be able to:

- Understand Pascal's Principle and how this principle is applied in hydraulic systems.
- Design and build a functioning hydraulic lift that will raise a toy car.

THIS LESSON FOCUSES ON

Engineering Design Cycle

- Designing Solutions
- Creating or Prototyping
- Refine or Improve

21st Century Skills

- Collaboration
- Critical Thinking
- Creativity

OVERVIEW

Students will learn the foundations of hydraulics, and how they make things move with little effort. Using these fundamentals, students will work together to design and engineer a functional hydraulic lift system. Additionally, they will analyze the relationships between pressure, area, and density, and evaluate the impact of hydraulics on manufacturing technologies.

STEM incorporates Science, Technology, Engineering, and Mathematics to focus on real-world issues and problems guided by the engineering design process. This type of instruction supports students in developing critical thinking, collaboration, reasoning, and creative skills to be competitive in the 21st-century workforce.

Each Siemens STEM Day classroom activity highlights one or more components of the engineering design cycle and an essential 21st-century skill.

MATERIALS

- "Understanding Pressure" handout, one per person
- Bin of Supplies, one per group
    - Include cardboard, medical syringes and tubing, hot glue gun, craft sticks, scissors, water, paper and pens/pencils.
- Computers with internet access

HAVE YOU EVER WONDERED . . .

Why your ears hurt when you swim to the bottom of a pool?

MAKE CONNECTIONS!

How does this connect to students?

In current society, there is constant **pressure** coming from a variety of sources. From the need to excel in school to diving under water, many students know firsthand the implications of pressure. Since perceived pressure is very different from applications of liquid pressure, students will benefit from understanding Pascal's Principle. This will ultimately help them better understand the science of pressure and fluid dynamics.

How does this connect to careers?

A **scuba diver** needs to have a keen understanding of pressure and how it works. The deeper one dives, the greater the pressure becomes due to the weight of the water.

A **mechanical engineer** applies the principles of engineering, physics and material science to the design, manufacturing, and maintenance of mechanical systems. This branch of engineering is needed in just about every field, from manufacturing to biomechanics.

How does this connect to our world?

Physics is a fundamental science discipline that involves understanding the workings of our world. Matter, motion, energy and forces are the key components of the natural science of physics. Gaining perspective on this scientific discipline helps people better understand the world in which they live.

Hydraulics involves the movement of liquid in a confined space under pressure, which can result in the transmission of energy. Hydraulic lifts and jacks, hydraulic braking systems, and hydraulic pumps are all real-world examples of Pascal's Principle.

BLUEPRINT FOR DISCOVERY

1. To engage students, perform a quick demonstration. Show a balloon and start to blow it up. Then pinch the balloon closed and ask them what will happen if you keep blowing into the balloon. Students will likely say that it will pop; ask them why they think the balloon will pop. Briefly discuss the students' thoughts. Next instruct the students to brainstorm as many examples as possible of **pressure** as they can. For example, they may identify water pressure, air pressure, or even perceived pressures such as excelling academically or in a sport.
2. To help students to understand the concept of pressure, explain to the students that they are going to use the "Under Pressure" Phet Simulation to explore the relationships between density, area, and pressure. Pass out the handout that students will use to document their findings. (https://phet.colorado.edu/en/simulation/under-pressure)

3. Provide the students with some background information on how hydraulic systems work by showing them the following video:
    - Fluids at Rest: Crash Course Physics #14
      https://www.youtube.com/watch?v=b5SqYuWT4-4

    Note: If time permits, you may choose to stop the video periodically to discuss the concepts in more depth.
4. Show the students a medium-sized toy car and explain that they are going to build a hydraulic lift that will raise the car. Instruct students to form groups of 3-4, and as they do that give a bin of supplies to each group of students.
5. Instruct the students to first draw some design prototypes that show how their lift will look. Optionally, you may choose to show students images of examples that are available online.
6. Provide the students with sufficient group work time for the design process. The students need to design, construct, test, and improve their group's hydraulic lift.
7. To conclude this lesson, pass out one "Group Feedback" handout to each student. As each group of students presents their construction to the class, instruct the other students to evaluate each group's design and provide them with some feedback.

TAKE ACTION!

- Students can further their understanding of pressure by solving problems that require the application of mathematical formulas. Use the following resource to help: https://www.plymouth.ac.uk/uploads/production/document/path/3/3755/PlymouthUniversity_MathsandStats_pressure.pdf

NATIONAL STANDARDS

Standards for Technology Literacy	Standard 8: Students will develop an understanding of Design. This includes knowing about the attributes of design. Standard 11: Students will develop Abilities for a Technological World. This includes becoming able to apply the design process. Standard 19: Students will develop an understanding of The Designed World. This includes selecting and using Manufacturing technologies.
Next Generation Science Standards	HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including costs, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. SEP 2: Developing and Using Models

UNDERSTANDING PRESSURE

Use the “Under Pressure” Phet Simulation to explore the relationships between density, area, and pressure. (https://phet.colorado.edu/en/simulation/under-pressure)

As you explore with the simulation, complete the See-Think-Wonder chart below to document what you see happening, what that makes you think, and lastly what you now wonder.

See—Think—Wonder Chart		
See What do you see?	**Think** What do you think is happening?	**Wonder** What does this make you wonder?

Concluding Statement

Explore the different gauges in the simulation to discover how you can change the amount of pressure. Using your observations above, write a statement that explains how pressure changes.

GROUP FEEDBACK

As you watch each group present their hydraulic lift to the class, provide them with some feedback for further consideration. Try to be specific with your responses.

I like…
I wish…
What if…
Additional comments…

GROUP FEEDBACK

As you watch each group present their hydraulic lift to the class, provide them with some feedback for further consideration. Try to be specific with your responses.

I like…
I wish…
What if…
Additional comments…