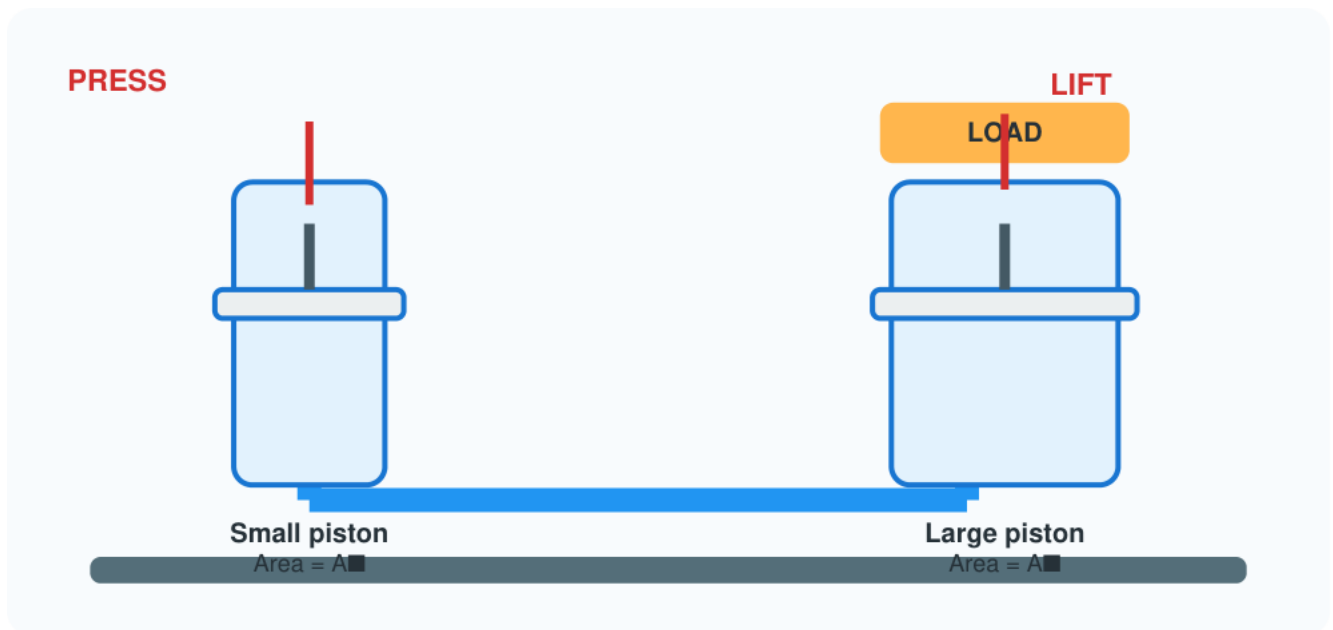


HYDRAULIC LIFT

Mathematics of Ratios & Area
A working school exhibition model



BIG IDEA: A small force on a small piston can create a larger force on a larger piston because the pressure is transmitted through the water.

What you will demonstrate

- Two syringes connected with water
- Different piston areas
- Small force → larger lifting force
- Simple area and ratio calculations
- Real hydraulic machines

1. THE MATHEMATICS

Hydraulic systems work because the pressure applied to a confined liquid is transmitted through the liquid.

Pressure

$$\text{Pressure} = \text{Force} \div \text{Area}$$

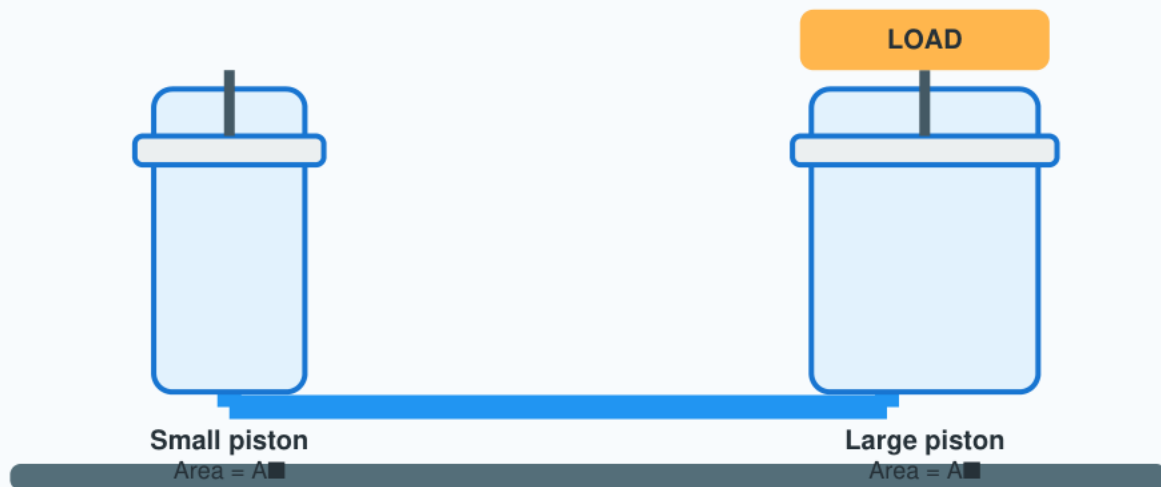
Because pressure is the same in both connected pistons:

$$F_{\text{small}} / A_{\text{small}} = F_{\text{large}} / A_{\text{large}}$$

Example: Small piston area = 2 cm² Large piston area = 10 cm²
Input force = 20 N

$$F_{\text{large}} = F_{\text{small}} \times (A_{\text{large}} / A_{\text{small}}) = 20 \times (10 / 2) = 100 \text{ N}$$

SMALL FORCE



Force multiplication = $10 \div 2 = 5$ times.

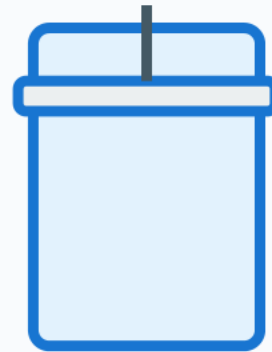
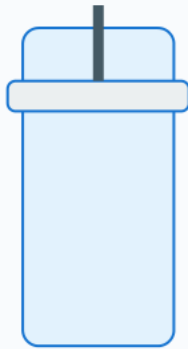
2. BUILD THE WORKING MODEL

Materials

2 syringes	Flexible plastic tube	Water
Cardboard/wood base	Tape or glue	Small load/weights

STEP 1

Fix two syringes upright on a strong base.



STEP 2

Connect the syringe outlets with a flexible tube.

Fill the tube and syringes completely with water.

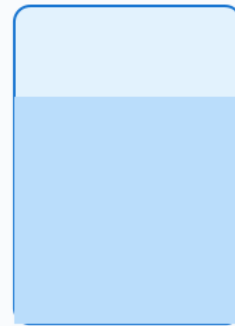
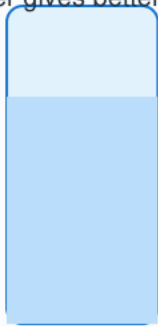


3. FINISH & TEST

STEP 3

Check for air bubbles and leaks.

Air-free water gives better pressure transfer.

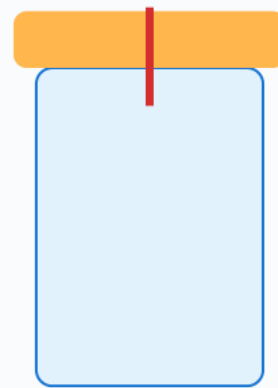


STEP 4

Press the small piston.

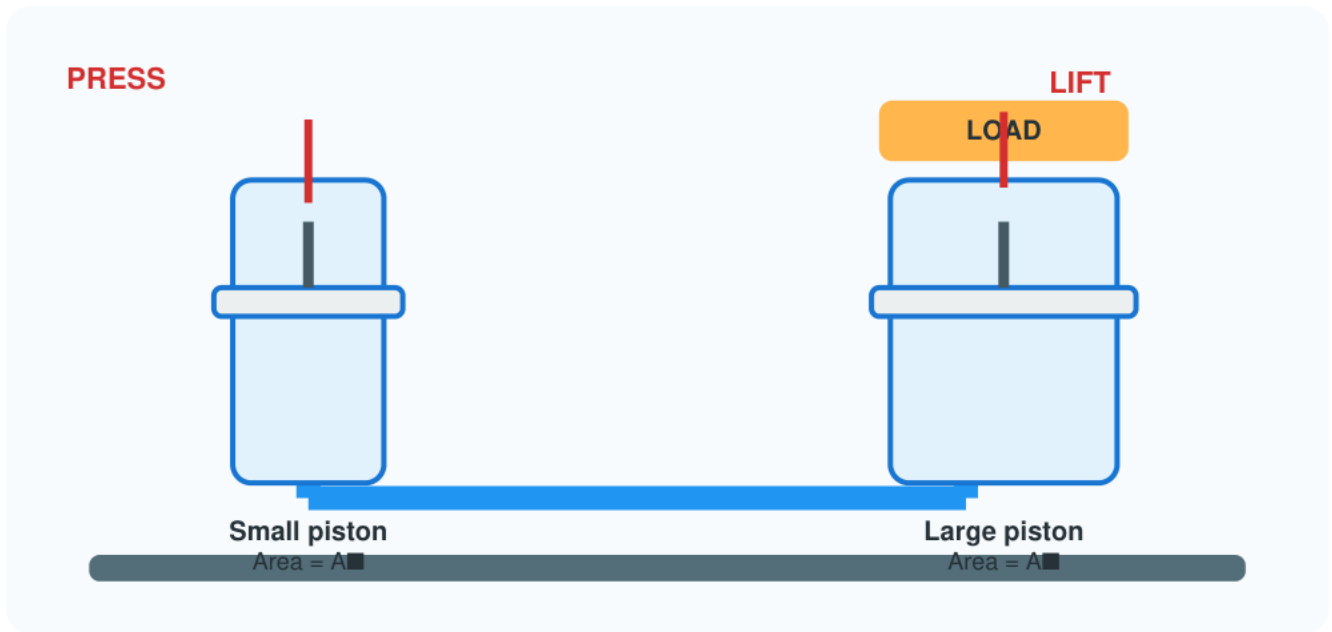


The larger piston rises!



EXHIBITION TIP: Use coloured water, label A■ and A■, and keep the large piston under a light object so the lifting action is easy to see.

4. PRESS HERE → LIFT HAPPENS



DEMONSTRATION

1. Put a small load on the large piston.
2. Press the small syringe slowly.
3. Watch the large piston rise.
4. Explain: the water transfers pressure, while the larger area produces a larger output force.

Try changing the piston areas and predict what will happen before pressing.

5. WHERE DO WE USE IT?

■ Car service lift

A mechanic can raise a heavy car using hydraulic pressure.

■ Hydraulic brakes

A force at the brake pedal is transmitted through brake fluid to the brakes.

■ Hydraulic machines

Presses, excavators and lifting equipment use the same pressure-and-area principle.

FINAL TAKEAWAY

Same pressure + bigger area = bigger force

One-line explanation for the exhibition:

“When I press the small piston, pressure travels through the water. Since the other piston has a larger area, it produces a larger force and lifts the load.”

Mathematics used: Area • Pressure • Ratios • Force