Fluids
Liquid Pressure
Pascal's Principle
Measuring Pressure

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Covered in “Lecture Module” Videos

- course intro
- definition of fluid
- pressure
- elastic moduli
- course policies

Overview

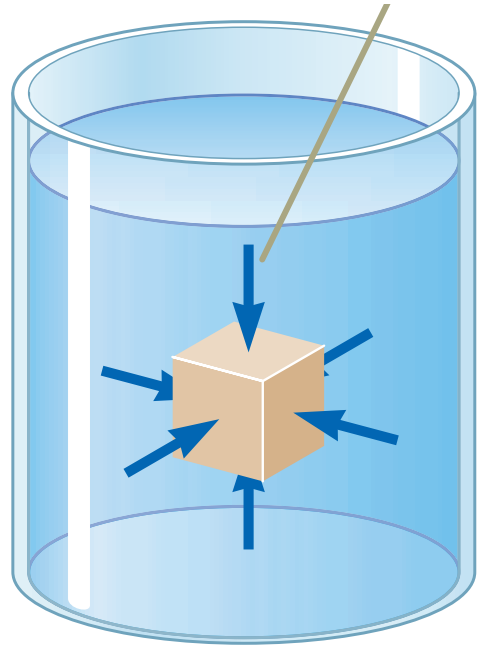
- remote learning & technology issues
- pressure and depth

Remote Learning / Technology

- Zoom recordings of lectures - will be loaded to OneDrive, under Office365 app in MyPortal
- WebAssign: you need to go to WebAssign from Canvas to see the materials for this course; there is no course key!
- submitting pdfs to Canvas, you can scan with your phone (AdobeScan, CamScanner, TapScanner, iPhone Notes, or Microsoft Office Lens)
- short Zoom meetings with me
- please read your email & course announcements

Fluid Statics

We first consider fluid statics: fluids at rest in a container.



Fluids will exert *pressure* on objects submerged in them and also on the walls of the container.

Pressure in a Liquid in a Gravitational Field

In a uniform gravitational field, liquid pressure depends on depth.

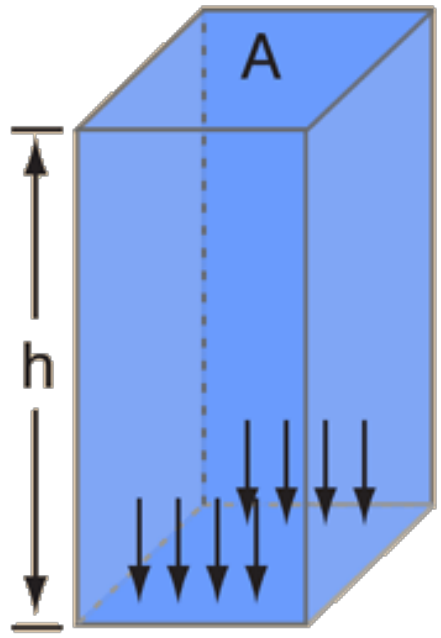
$$P_{\text{liq}} = \rho g h$$

where $\rho = m/V$ is the mass density of the liquid and h is the depth.

It does not depend on the total amount of water involved, just the depth of water.

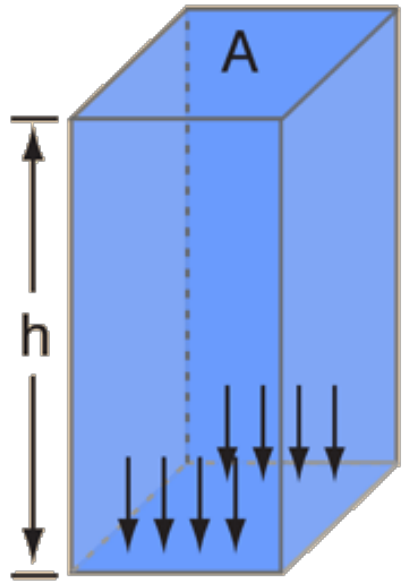
Liquid Pressure

A slice of liquid of cross section A at a depth h must support all the water in a column directly above it.



The force exerted downward by the column of water is $F = mg = \rho Vg$.

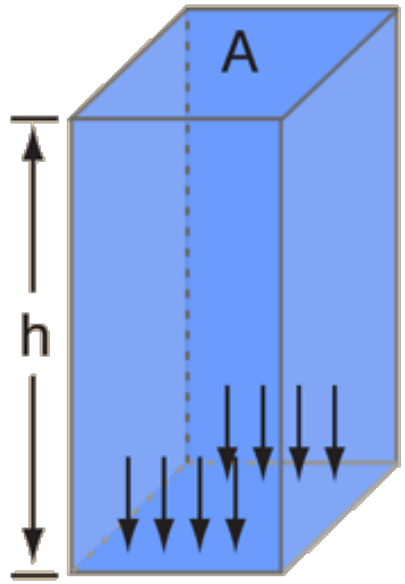
Liquid Pressure



$$F = mg = \rho Vg = \rho Ahg$$

[1] Figure from HyperPhysics.

Liquid Pressure



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Pressure, $P_{\text{liq}} = \frac{F}{A} = \frac{\rho Ahg}{A} = \rho gh.$

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Total Pressure

The liquid pressure only expresses the pressure due to the weight of the fluid above.

However, this is not the total pressure in most circumstances, *eg.* diving on earth.

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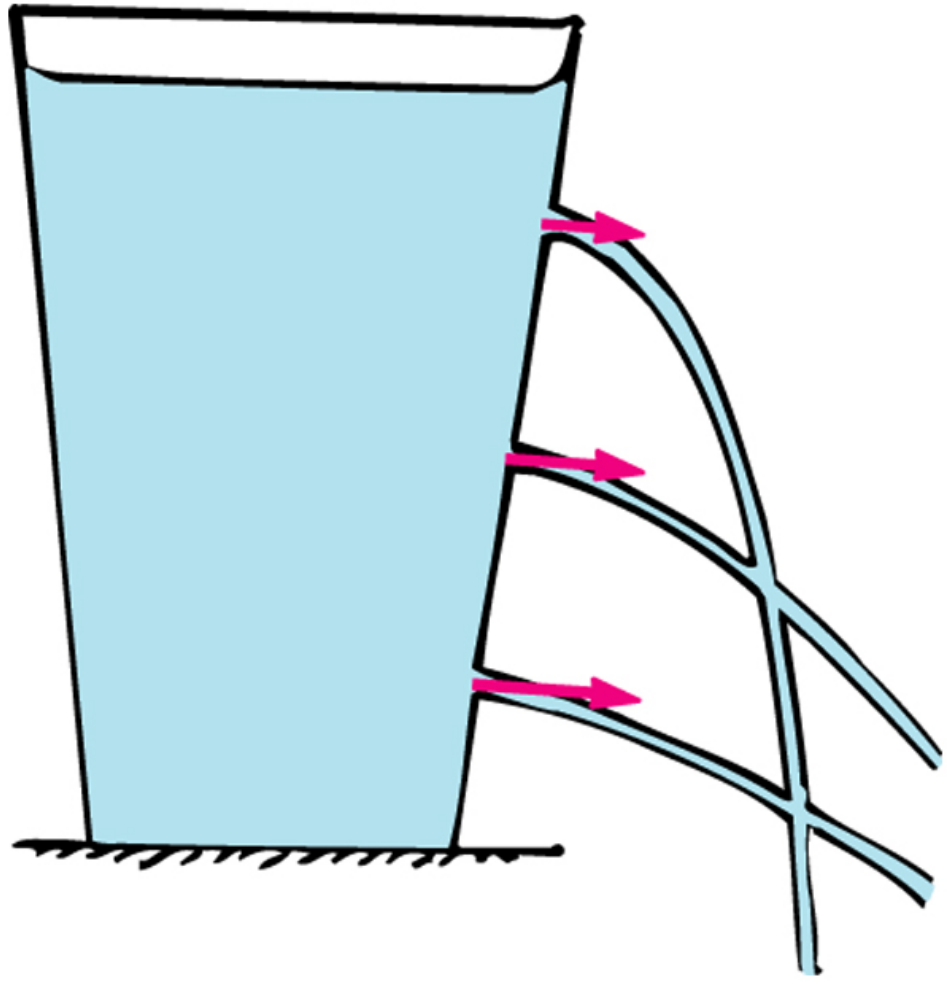
The total pressure or **absolute pressure** is the sum of the pressure due to the liquid *and* the pressure due to the atmosphere.

$$P_{\text{total}} = P_0 + \rho g h$$

where $P_0 = P_{\text{atm}} = 1.013 \times 10^5$ Pa.

Pressure varies with Depth



Pascal's Barrel

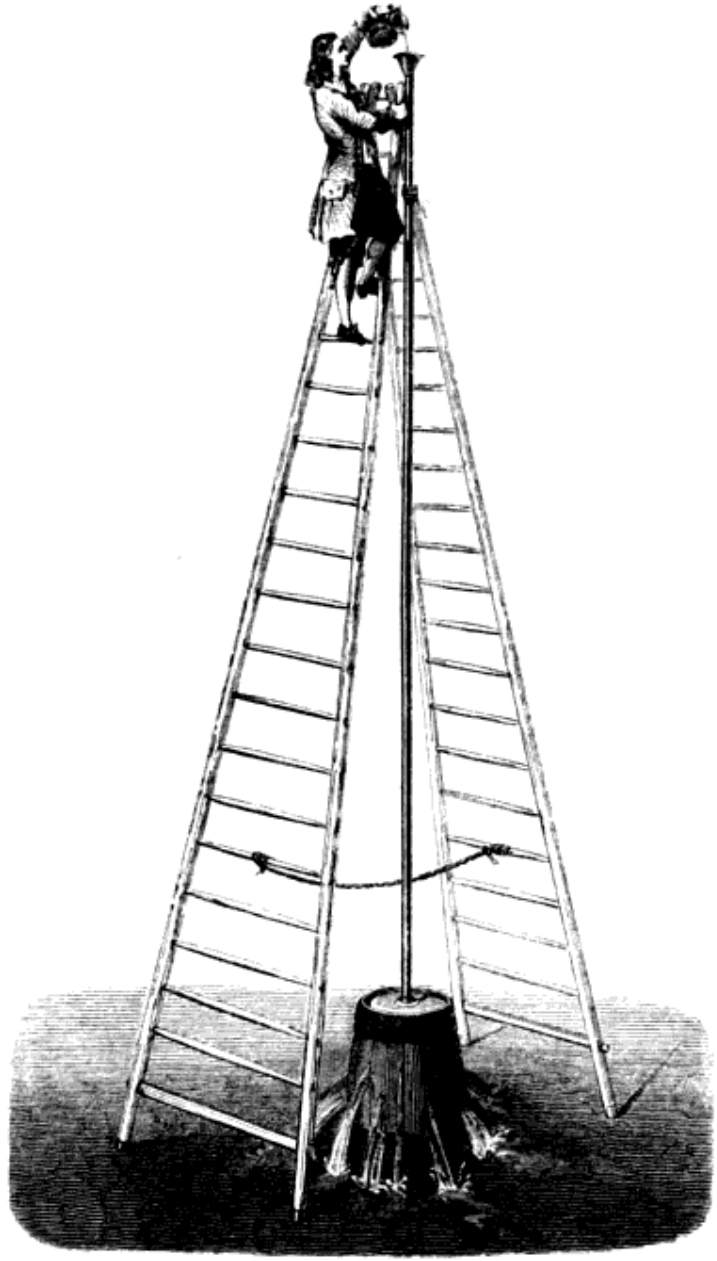


Fig. 45.—Hydrostatic paradox. Pascal's experiment.

Density of Water

For water:

$$\rho_w = 1.00 \times 10^3 \text{ kg/m}^3$$

That is $\rho_w = 1 \text{ g/cm}^3$.

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Originally, the gram was defined to be the mass of one cubic centimeter of water at the melting point of water.

Questions

Calculate the water pressure at the base of the Hoover Dam. The depth of water behind the dam is 220 m.[1]

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[3]See example 14.4, page 422, Serway & Jewett, 9th ed.

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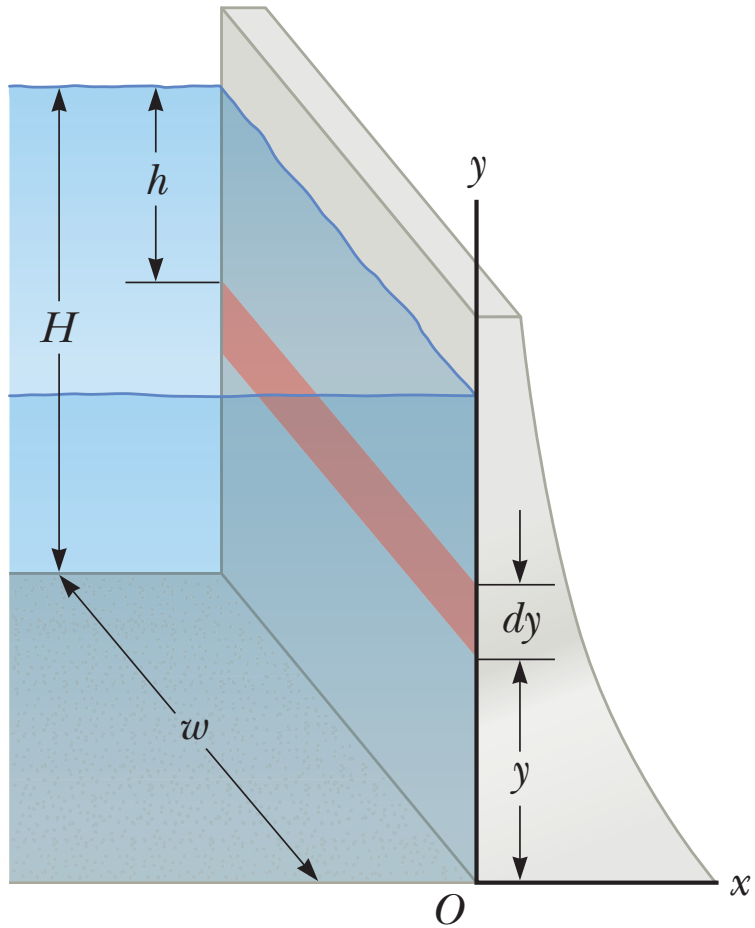

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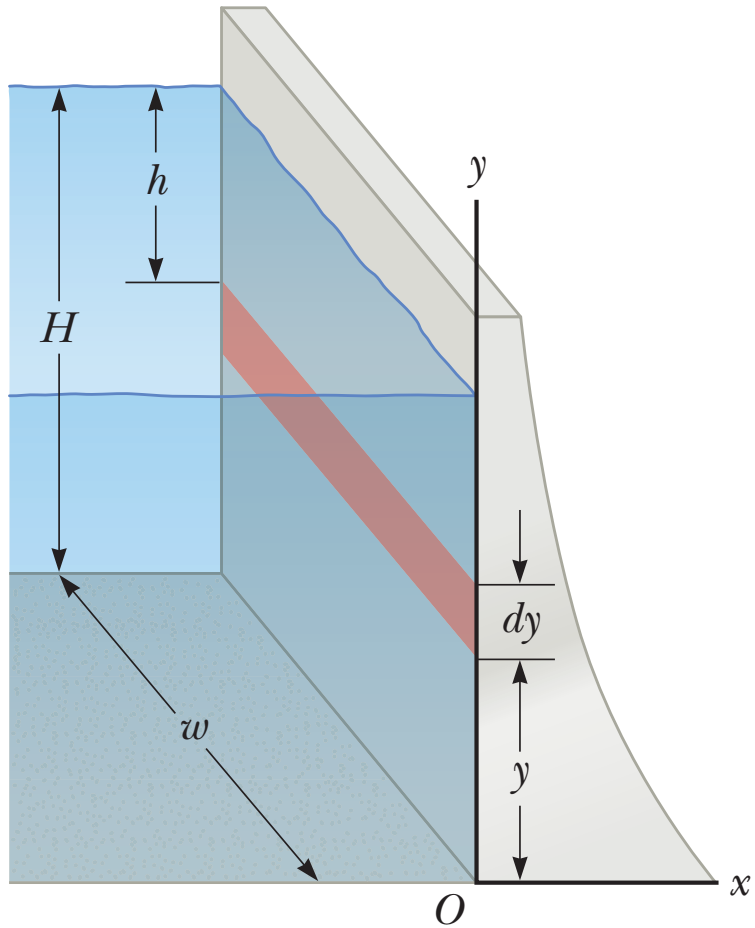

$F = 9.0 \times 10^{10}$ N

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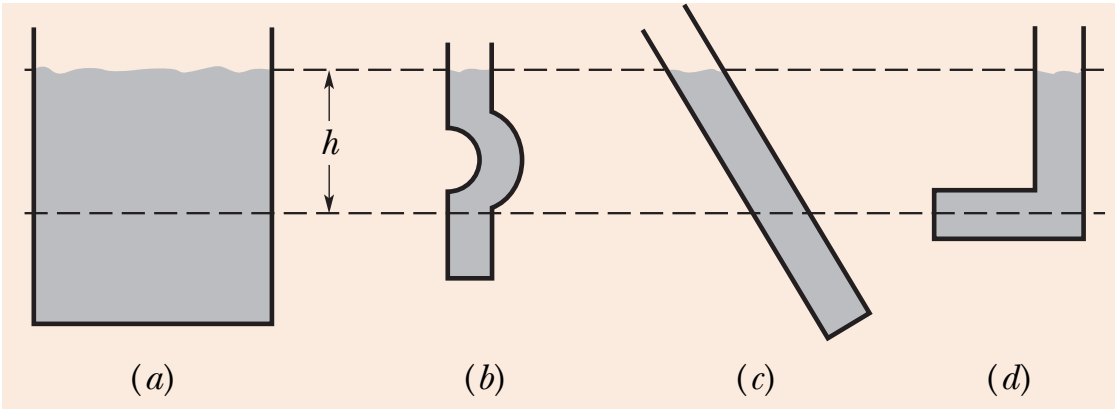
Liquid Pressure Question

The figure shows four containers of olive oil. Rank them according to the pressure at depth h, greatest first.[3]



A a, b, c, d

B a, d, c, b

C a, c, d, b

D All the same

[3] Halliday, Resnick, Walker, 9th ed, page 363.

Summary

- pressure and depth

Test Wednesday, April 22, in class. (TBC!)