Ch 12.3-5
Buoyancy & Fluid Flow

PHYS 1210 -- Prof. Jang-Condell

Which grading system do you prefer for your final grade?

A. Letter grades only (A, B, C, D, F)

B. Plus/minus grading (A, A-, B+, B, B-, etc.)

C. Don't care

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PI A PROF

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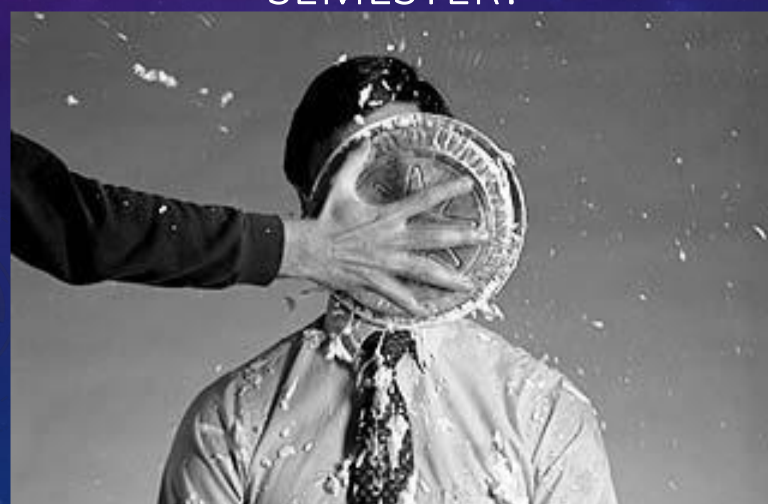
AT THE END OF THE SEMESTER, THE MONEY FOR EACH PROFESSOR WILL BE TOTALED. FOR EVERY $50 IN THEIR BOX, EACH PROFESSOR WILL HAVE A WHIP CREAM PIE THROWN IN THEIR FACE AT THE END OF THE SEMESTER!



Boxes are located in the Physics & Astronomy Main office PS 204

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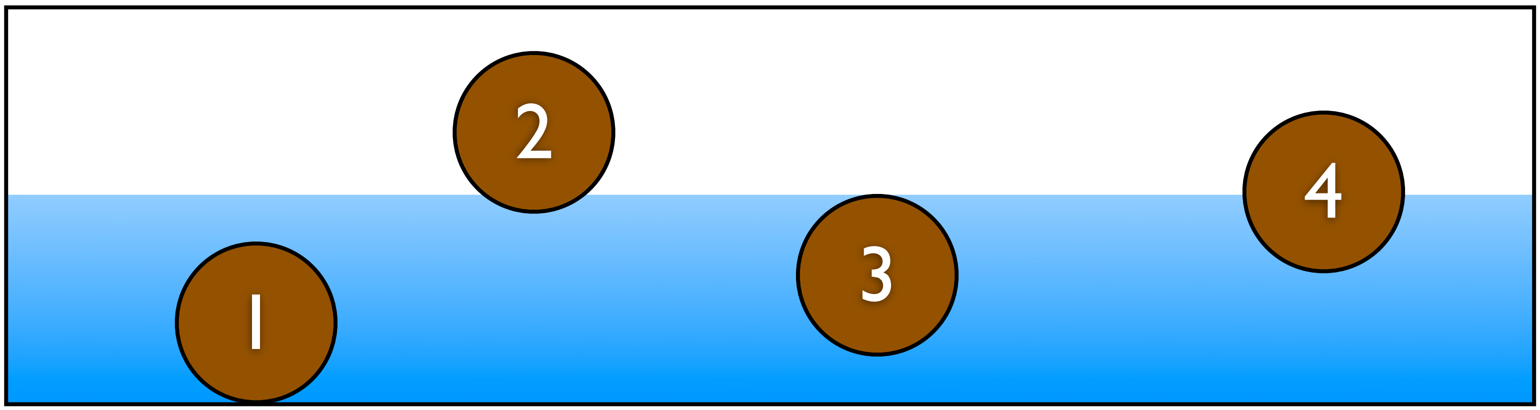
Goals for Chapter 12

- To study the concept of density
- To investigate pressure in a fluid
- To study buoyancy in fluids
- To compare laminar versus turbulent fluid flow and how the fluid speed depends on the size of the tube
- To learn how to use Bernoulli's equation to relate pressure and flow speed of a fluid

- The **gauge** pressure is the pressure above atmospheric pressure. The **absolute** pressure is the total pressure.
- When you measure your bike tire's pressure to be 40 pounds per square inch (psi), that is its **gauge** pressure.
- If the air pressure in Laramie is 0.77 atm, what is the **absolute** pressure of the bike tire?
- If you ride your bike to Ft. Collins, where the air pressure is 0.85 atm, what is the **gauge** pressure of the tire?

Buoyancy

Rank these objects in water from smallest to greatest density.



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Archimedes
ca. 287-ca. 212 BCE

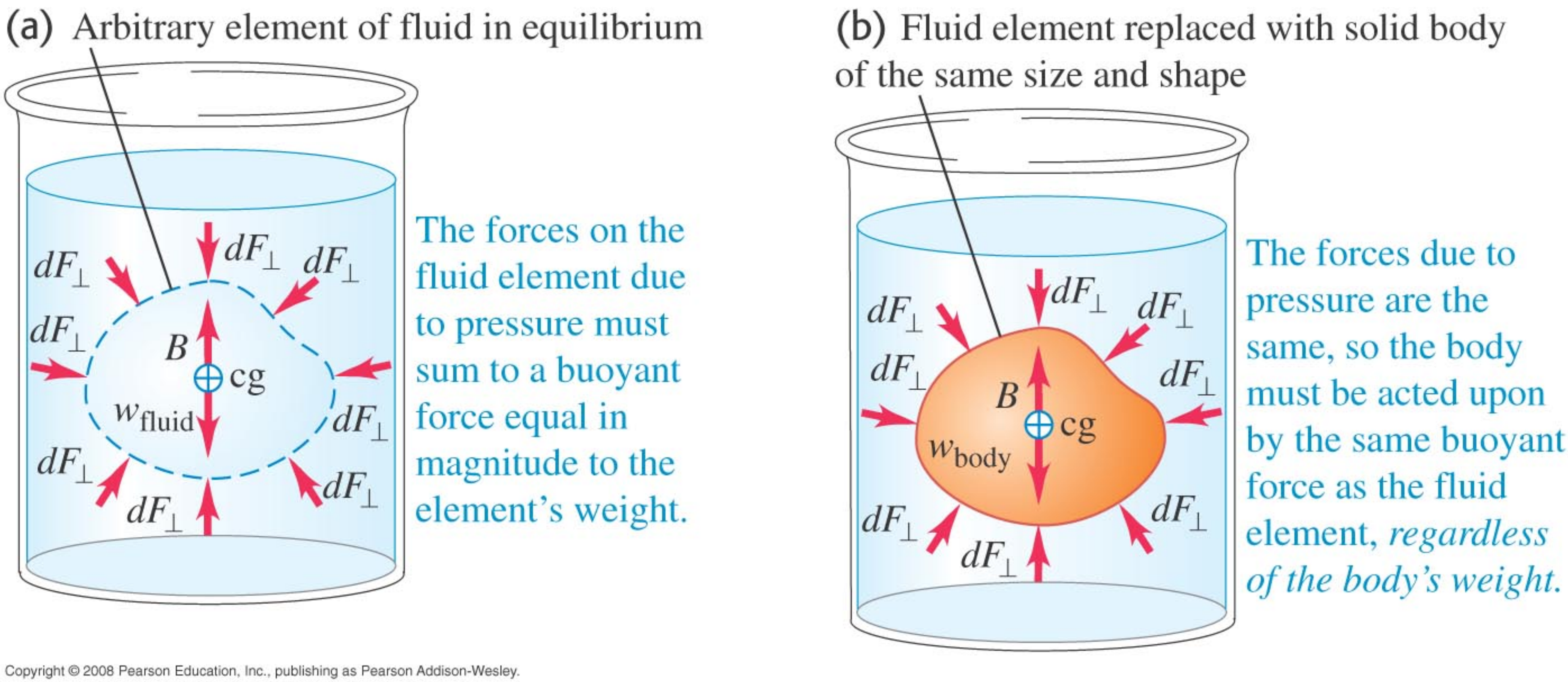
Ancient Greek mathematician

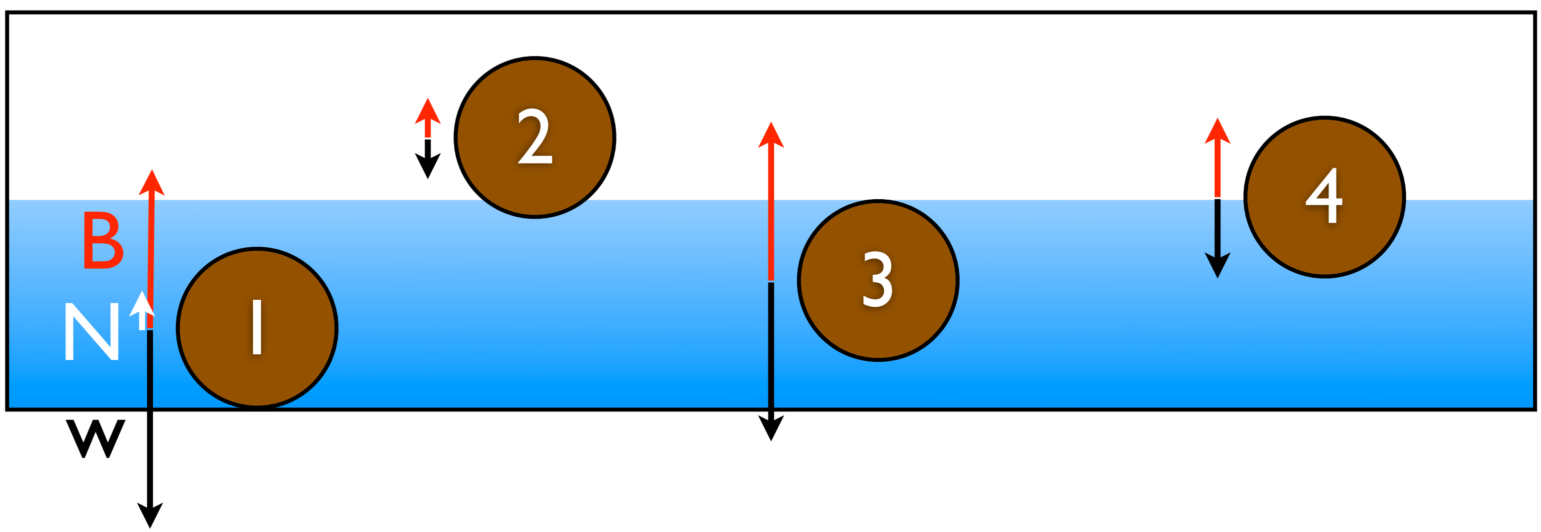
Eureka!

King Hiero II had a gold crown made for himself, and asked Archimedes to determine if it was pure gold. Thinking about this while taking a bath, Archimedes realized that the volume of water displaced would be the volume of the crown.

Archimedes Principle

- *Archimedes' Principle*: When a body is completely or partially immersed in a fluid, the fluid exerts an upward force (the "buoyant force") on the body equal to the weight of the fluid displaced by the body. (See Figure 12.11 below.)



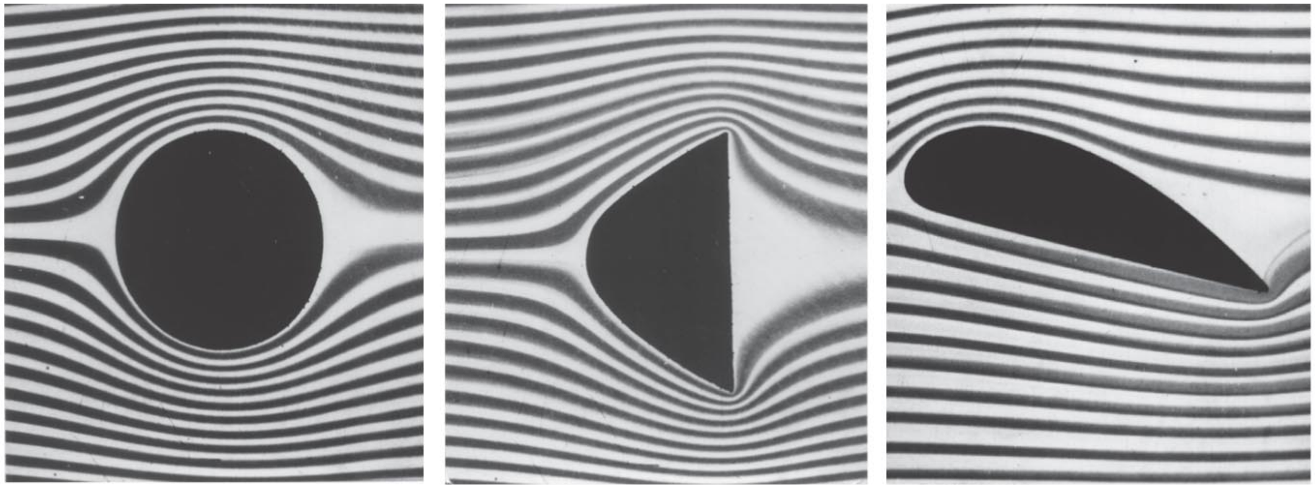


$$B = g\rho_{fluid}V$$

Fluid flow

Fluid flow

- The flow lines in the bottom figure are *laminar* because adjacent layers slide smoothly past each other.
- In the figure at the right, the upward flow is laminar at first but then becomes *turbulent flow*.

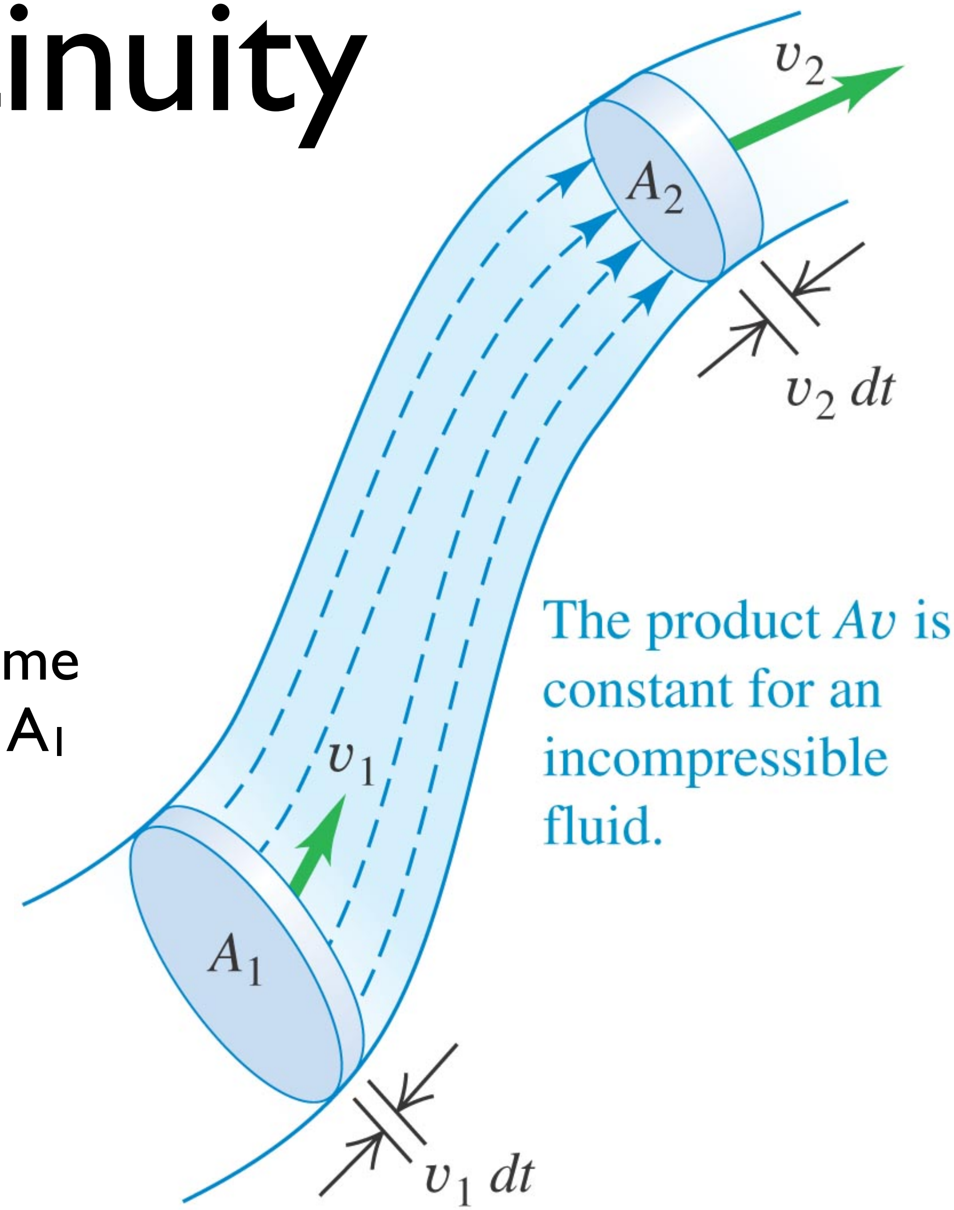


Continuity

Consider a pipe with varying cross-sectional area.

Over a time interval dt, the same amount of fluid flows through A_1 as A_2.

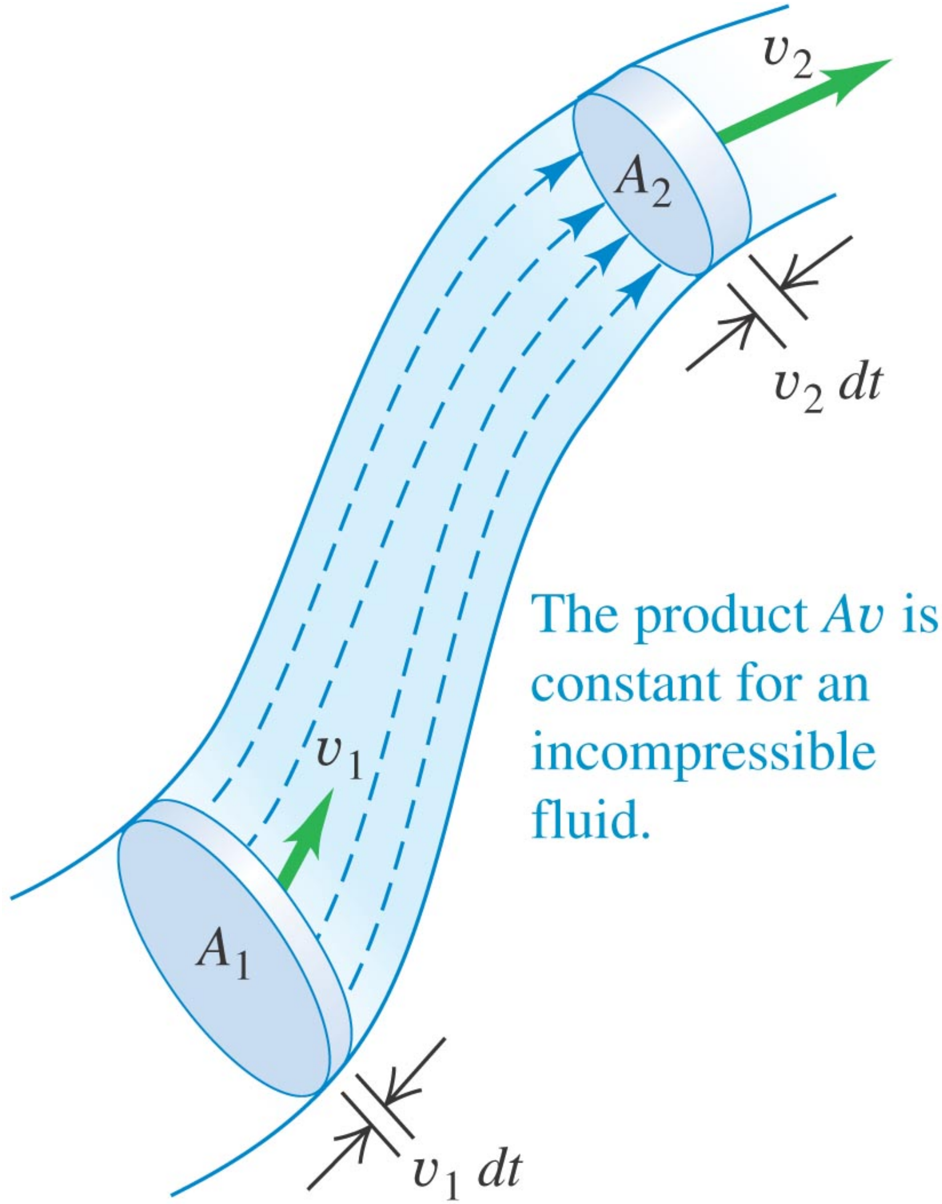
$$dm = \rho\, A\, v\, dt$$



The continuity equation

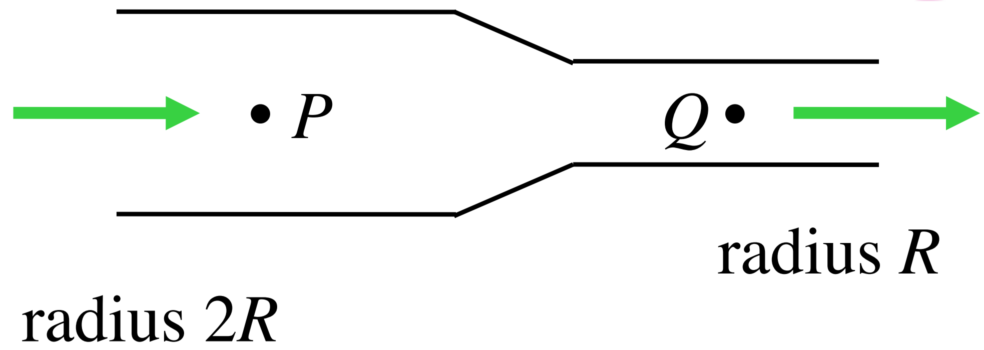
- The *continuity equation* for an incompressible fluid is $A_1 v_1 = A_2 v_2$.
- The *volume flow rate* is $dV/dt = Av$.
- For a compressible fluid (e.g. some gases), the continuity equation is

$$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$$



Q13.5

An incompressible fluid flows through a pipe of varying radius (shown in cross-section). Compared to the fluid at point *P*, the fluid at point *Q* has



F. 4 times the fluid speed.

G. 2 times the fluid speed.

H. the same fluid speed.

I. 1/2 the fluid speed.

J. 1/4 the fluid speed.

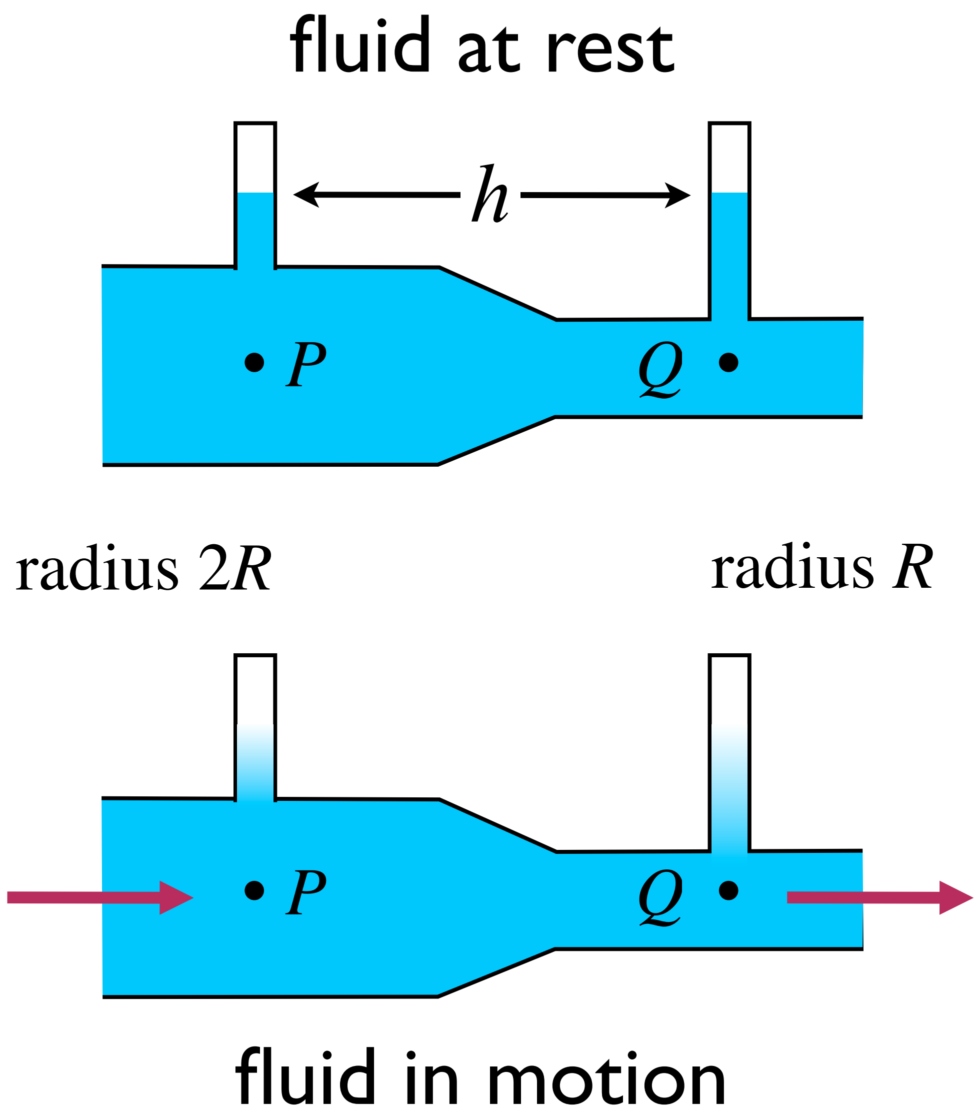
Bernoulli's Equation

$$p_1 + \rho g y_1 + 1/2\ \rho {v_1}^2$$

$$=$$

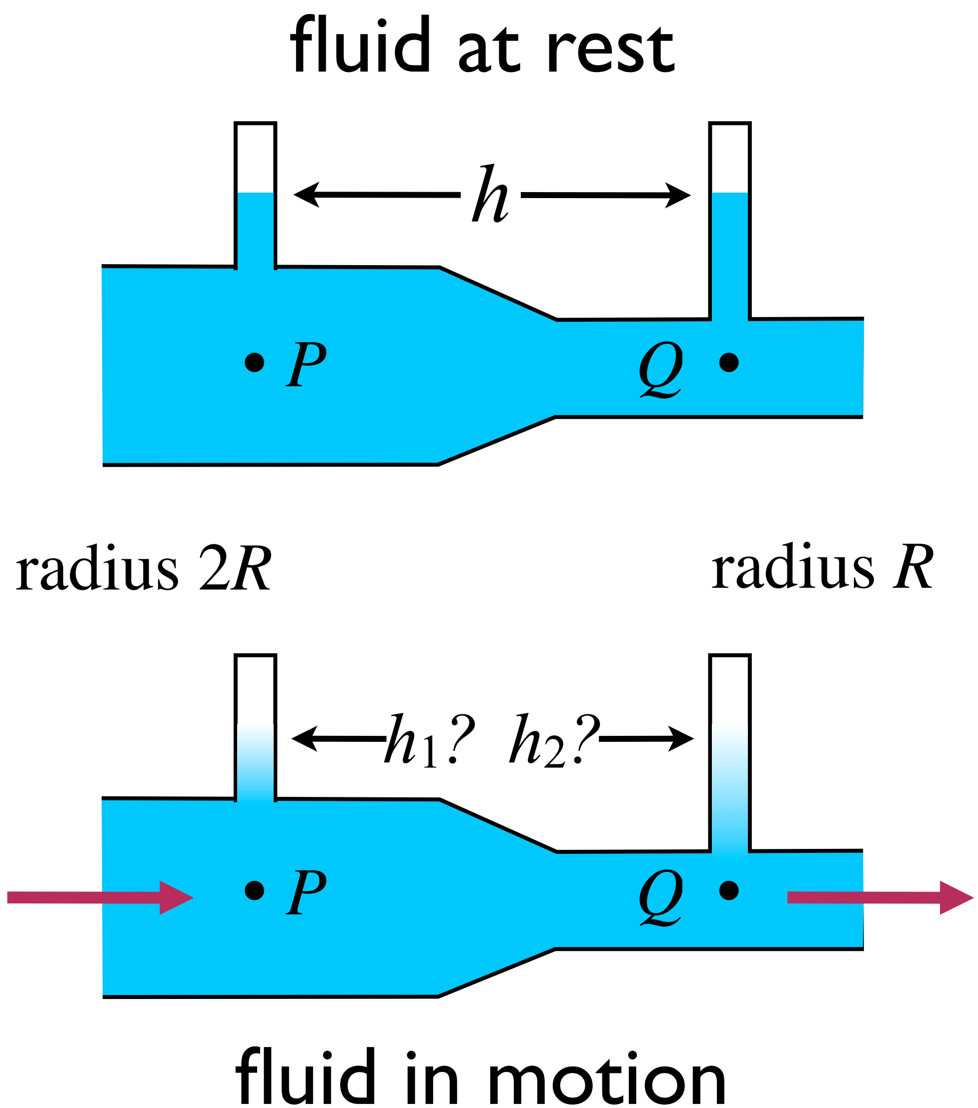
$$p_2 + \rho g y_2 + 1/2\ \rho {v_2}^2$$

Venturi meter



How does the pressure compare at points P & Q?

Venturi meter



When the fluid is in motion,

K. $h_1 = h_2$

L. $h_1 < h_2$

M. $h_1 > h_2$

N. None of the above

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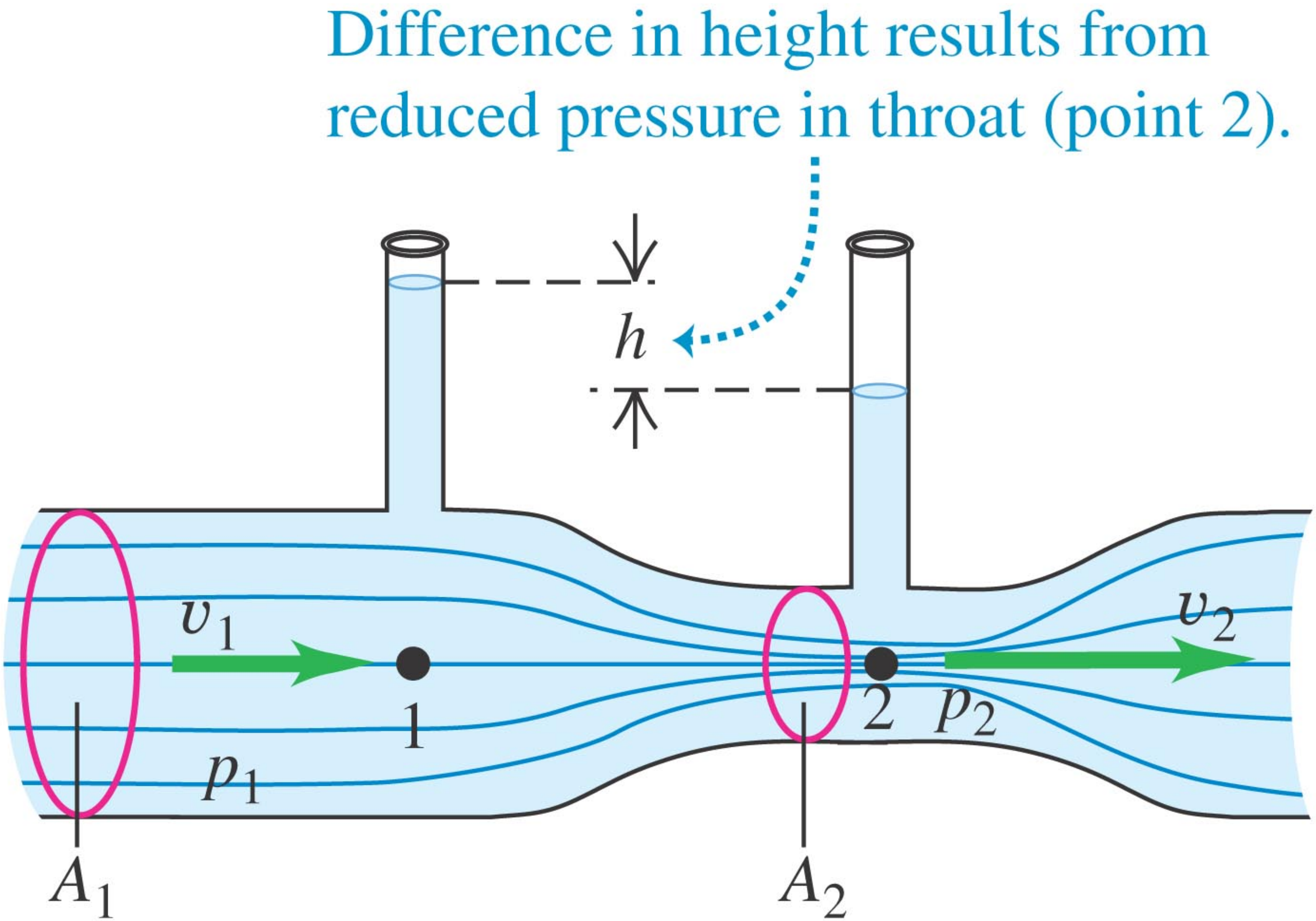
The Venturi meter



Lift on an airplane wing

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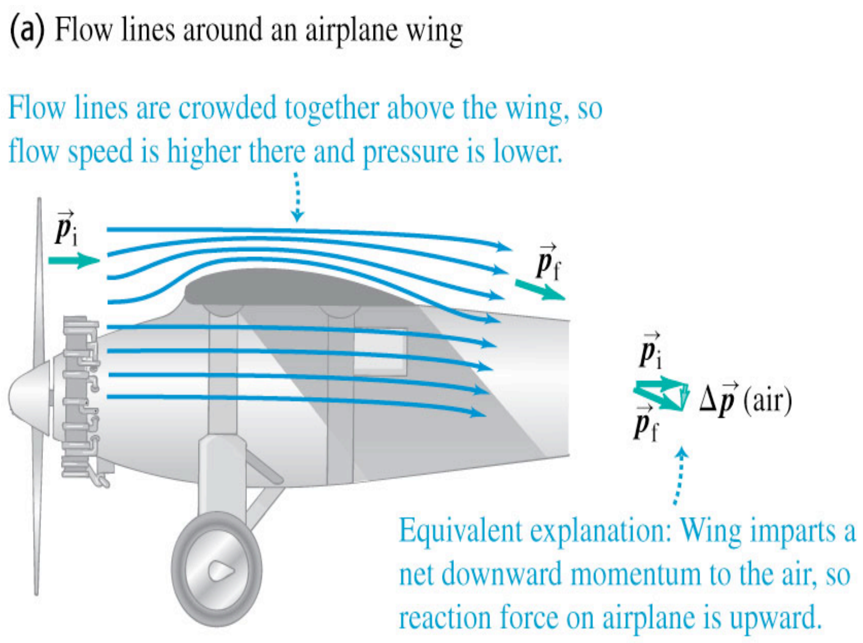
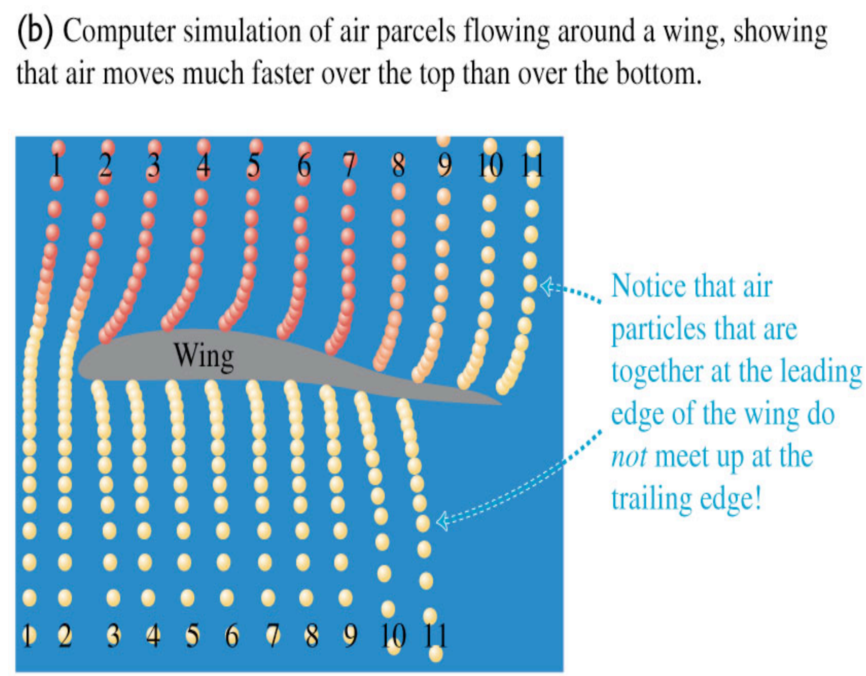
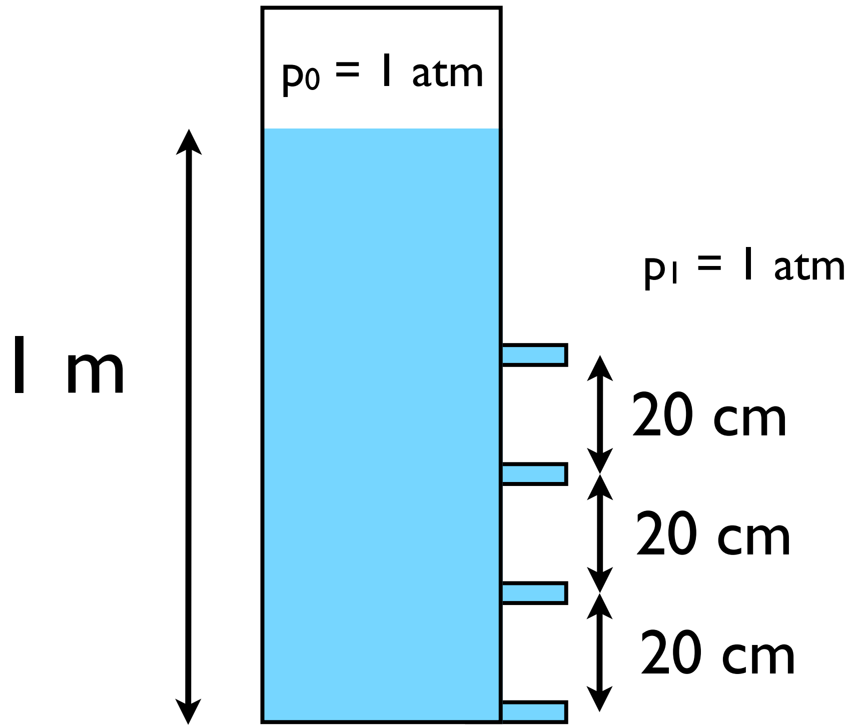




The Leaky Tower



Each pipe has a diameter of 1 cm. At what speed will the water come out from each pipe?