Announcements

1. Exam 3 starts Friday!!
   a. Starts on Friday, goes to Monday, as usual
   b. Covers momentum, circular motion, torques, etc.
      i. Chapters 6-8 in your textbooks
      ii. Up through HW 16
         1. (HW 16 due tonight)
   c. Not fluids, pressure, etc.
2. Thursday will be an exam review
3. Late submissions for HWs 10 through 16 are due Friday evening
4. (I sent an email) HW 17 problem 2 is missing an answer range. It should be: 1.050e5, 1.070e5 Pa

Fluid dynamics

Friction between wall and fluid

Friction cases a loss in _____ along the tube as fluid flows.

Friction effects depend on radius _____
and length _____

As friction grows, pressure at inlet must _____ .

Friction in fluids: *viscosity*

Now we'll ignore viscosity effects…

Bernoulli effect

The pressure in a fluid changes with the _____of the fluid.

Demo**:** Bernouilli effect in glass tube with varying diameter

Fluid speeds

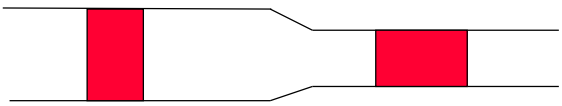
Volume flow rate: m^3/sec past any point

$$\text{VFR} = \frac{\Delta Volume}{\Delta t} = \frac{Area\ \Delta x}{\Delta t}$$

Assume:

- No friction, viscosity
- Incompressible (constant density) – *not true for gases*
- No turbulence

Conservation of Mass + Constant Density = Conservation of volume flow



"Equation of Continuity": $A_1 v_1 = A_2 v_2$ if no density change

Bernoulli effect

Moving water has *kinetic energy*
KE/volume =

Water in small area moves _____.

A net force must _____ the water, so pressure must be greater _____.
Demo: air over manometer

Bernoulli's equation

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}$$

Work/Vol KE/Vol PE/Vol

Or…

(Note: This pressure change is **on top** of viscosity effects.)

Water flows from the little pipe into the big pipe. Ignore any friction or height change.

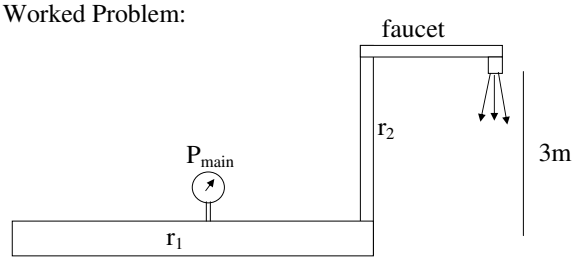
R= 6 cm R = 2cm

Q4. The pressure in the right side is _____ than on the left
a. greater than
b. same as
c. less than

Q5. The volume flow rate on the right is _____ than on the left.
a. greater than
b. same as
c. less than

Q6. The ratio of the velocity on the left vs. on the right:
(v_{right}/v_{left}) =_____
a. 1/9
b. 1/3
c. 1
d. 3
e. 9

Worked Problem:

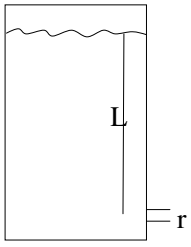


The faucet of radius r_2=2 cm puts water out at 15 liters/minute. The pressure at the opening of the faucet is about 1atm. The water main (r_1=6 cm), is 3 meters below the faucet

a. What is the speed of the water in the narrow pipe?

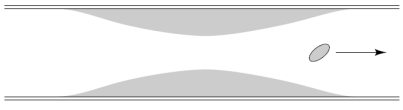
b. What is the pressure in the water main?

Fruit Punch out of a Cooler:



Q7. If the punch level goes down (smaller L), the arc will…
A. move to the right B. move left C. not change

Q8. If a second cooler with a larger hole (same L, smaller r) is used, its arc will be _____ compared to the initial cooler.
A. to the right B. to the left C. unchanged



Q9. A blood platelet drifts along with the flow of blood through an artery that is partially blocked by deposits. As the platelet moves from the narrow region to the wider region, it experiences…
a. an increase in pressure.
b. no change in pressure.
c. a decrease in pressure.

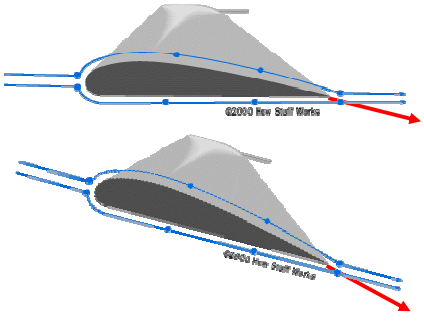
The Bernoulli effect

Demos: Blowing on paper, Ball over blower, Venturi blower, funnel, metal plate and wood cylinder

Airplane Wings (and Sails, and other "airfoils")

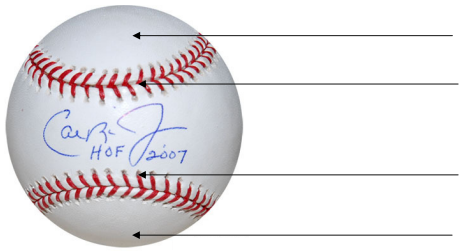
Principle 1: air deflection

Principle 2: Bernoulli



Curve balls

ball moving to the right (i.e. air moving to left)



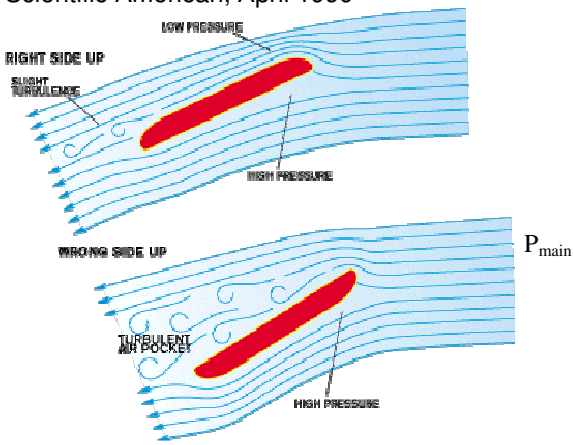
Bernoulli

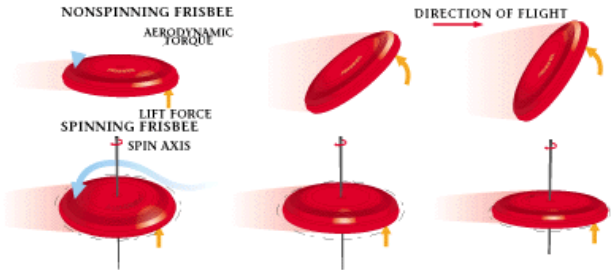
air deflection?

Demos: ping pong ball, scoop thrower and foam ball

Frisbees

Scientific American, April 1999





Worked Problem: A flat roof of area 400 m^2 will rip off if it is subjected to a lift force of 5×10^5 N. What speed of horizontal wind will rip off the roof? (Neglect the weight of the roof)
$\rho_{air} = 1.29$ kg/m^3

Q10. A ball is thrown toward you, spinning so that the left side of the ball spins toward you, and the right side away. The ball will

a. "float" more than a nonspinning ball
b. "sink" (fall) faster than a nonspinning ball
c. curve to your left
d. curve to your right

Q11. Did you discuss at least half of the discussion quiz questions today with a neighbor?

a. Yes b. No