Movie project due today!

11:59pm.

Turn in on eCampus.

I won’t be available for rest of day. Direct any questions to your fellow classmates (e.g. real life or class Facebook group!).

Velocity

\[ v = \Delta x/t \]

Acceleration

\[ a = \Delta v/t \]

Volume flow rate

= Volume through a surface per time

Rates and fluid flow

Cows sometimes eat small rocks and particulates. Water (an “ideal fluid”) moves rapidly, and saliva/saliva help flush these materials from their stomachs.

A cow swallows about 100 liters (0.1 m³) of saliva each day. Assuming cow swallows it all, what is the volume flow rate (volume per unit time) of saliva into the cow?

- A. 0.1 m³/s
- B. 1.2 x 10⁻³ m³/s
- C. 1.2 x 10⁻⁶ m³/s
Assumptions Today

- Non-viscous fluid (no internal friction.)
  Note: Honey is viscous. Mud is viscous. Water is not.
  Blood **SHOULDN'T** be viscous!
- Density is constant.
- Fluid motion is steady.
- No turbulence in the fluid.

\[ \frac{\text{Volume}_1}{\text{time}} = \frac{\text{Volume}_2}{\text{time}} \]

Rate of mass in = Rate of mass out

\[ \frac{A \Delta x}{t} = A \nu \]

Rate of mass in = Rate of mass out

\[ A \Delta x = A \nu \]

“Continuity” Equation

Flow rate is FASTER if pushed through a smaller cross-sectional area.

\[ A_1 \nu_1 = A_2 \nu_2 \]
What do you do if your garden hose does not reach all of your plants?

\[ A_1 v_1 = A_2 v_2 \]

Aneurysms
Is the blood flow faster in a normal blood vessel or in a blood vessel with aneurysm?

- Sacular aneurysm
- Fusiform aneurysm

A. Normal blood vessel
B. Aneurysm
C. Same in healthy and aneurysed vessel
D. Not enough information to determine

Bernoulli’s Principle
If volume flow rate is constant, and conservation of energy applies to fluids, then...

\[ P_1 + \frac{1}{2} \rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g y_2 \]

An important consequence
As a fluid goes through a region where it changes speed or height, the pressure of the fluid will change.

\[ P_1 + \frac{1}{2} \rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g y_2 \]

As height increases, pressure decreases. As speed increases, pressure decreases.
Careful!....Counter-intuitive!

\[ P_1 + \frac{1}{2} \rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g y_2 \]

Aneurysms

Is the PRESSURE higher in a normal blood vessel or in region with aneurysm?

- A. Normal blood vessel
- B. Aneurysm
- C. Same in healthy and aneurysed vessel
- D. Not enough information to determine

Bernoulli’s Most Important Implication.

A slow-moving fluid exerts more pressure than a fast-moving fluid (depends also on elevation of volume flow).

Consider a house with a very thin (Ay \sim \theta), flat roof of area 148.6 square meters. During a hurricane with winds of 140 mph (62.6 m/s), what is the net force on the roof?

\[ P_1 + \frac{1}{2} \rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g y_2 \]

Density of air: 1.225 kg/m³
Consider a house with a very thin (Ay ~ 0), flat roof of area 148.6 square meters. During a hurricane with winds of 140 mph (62.2 m/s), what is the net force on the roof?

\[ P_1 + \frac{1}{2} \rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g y_2 \]

If the wind is blowing very hard outside, What direction does the net force point?

A Bernoulli’s Most Important Implication.

A slow-moving fluid exerts more pressure than a fast-moving fluid (depends also on elevation of volume flow).

Airplane wings!

Faster air over

Slower air under

Higher pressure under the wing creates LIFT!