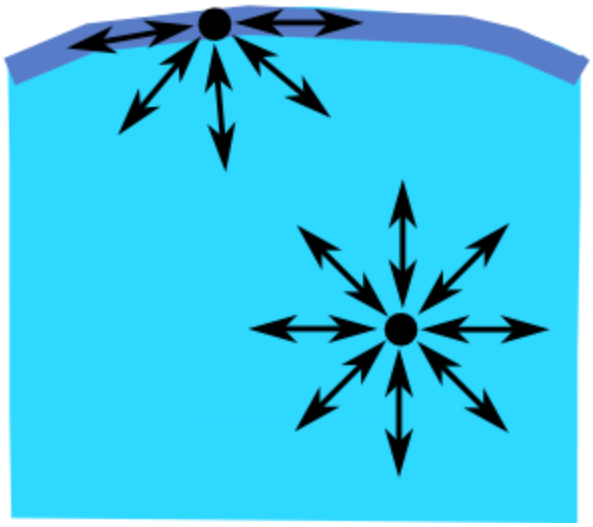
Lecture 31
(Fluid Mechanics II)

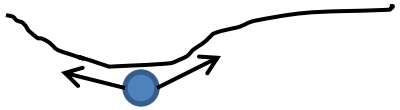
Physics 160-01 Fall 2012

Douglas Fields

Surface Tension

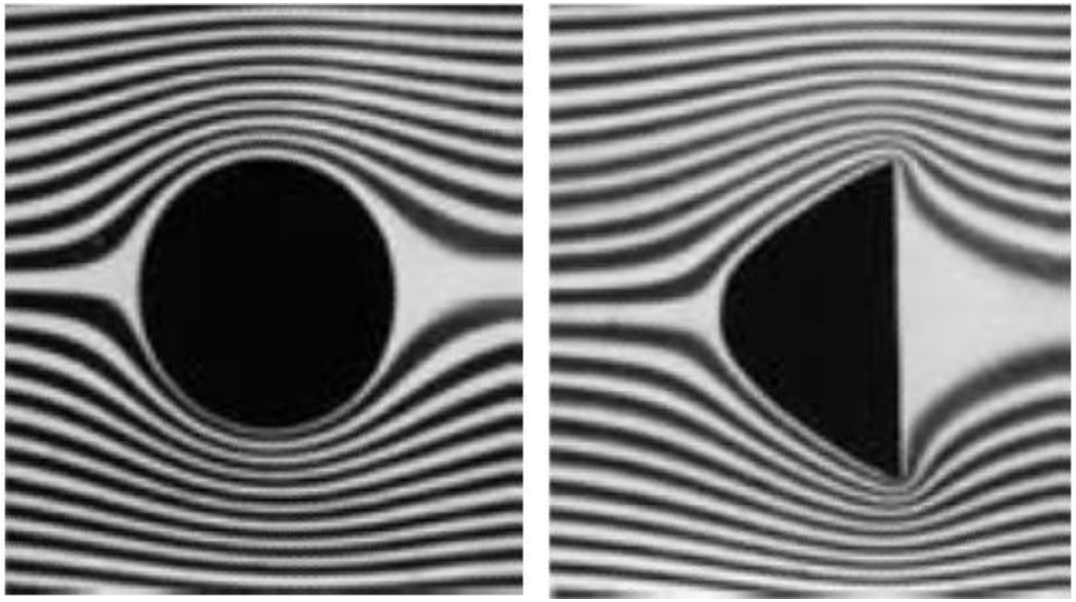
Surface Tension

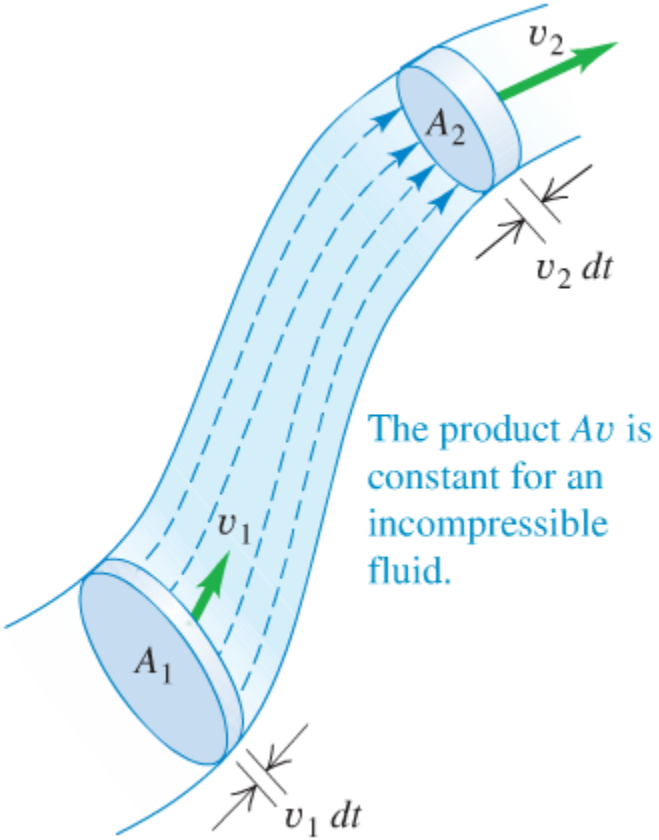




Fluid Flow

- Flow lines (or streamlines) show the motion of parts of the fluid.
- If the streamlines get closer together, the velocity must get higher.





Bernoulli's Equation

- Examine the movement of a bit of a fluid (from point a to point c) over a time Δt. Fluid at point a will move to point b during that time. Fluid starting at point c will move to point d during the same time.
- Now, let's use the work energy theorem: $dW = dK + dU$
- The work done by the external fluid from point a to b minus the work done by the external fluid from point c to d is:

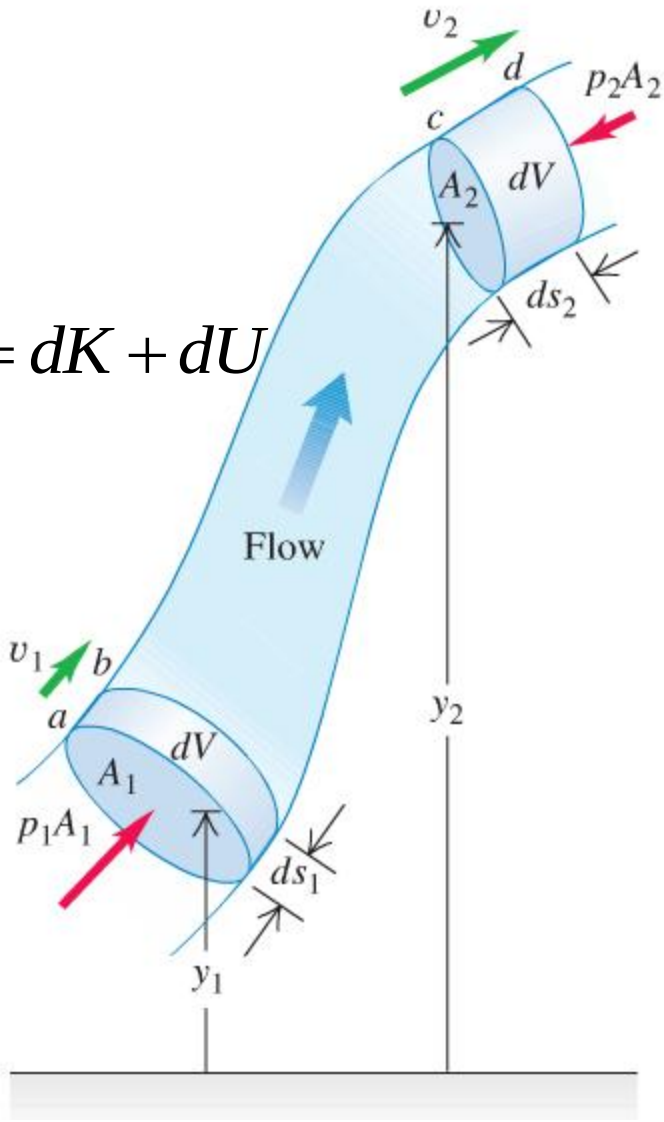
$$dW = p_1 A_1 ds_1 - p_2 A_2 ds_2 = \left(p_1 - p_2\right) dV$$

- The change in the kinetic energy of the fluid is just:

$$dK = \frac{1}{2}\rho dV\left(v_2^2 - v_1^2\right)$$

- The change in the gravitational potential energy is:

$$dU = \rho dV\left(y_2 - y_1\right)$$



Bernoulli's Equation

- Putting this all together, we have:

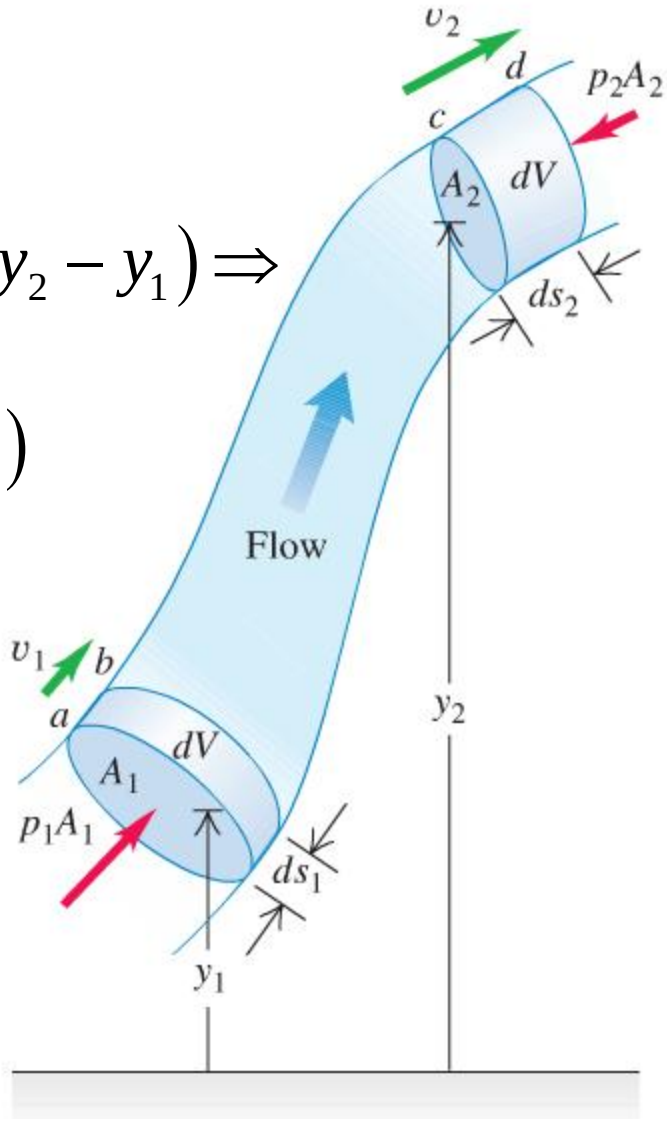
$$dW = dK + dU \Rightarrow$$

$$(p_1 - p_2)\,dV = \frac{1}{2}\rho dV\left(v_2^2 - v_1^2\right) + \rho dV\left(y_2 - y_1\right) \Rightarrow$$

$$(p_1 - p_2) = \frac{1}{2}\rho\left(v_2^2 - v_1^2\right) + \rho\left(y_2 - y_1\right)$$

or

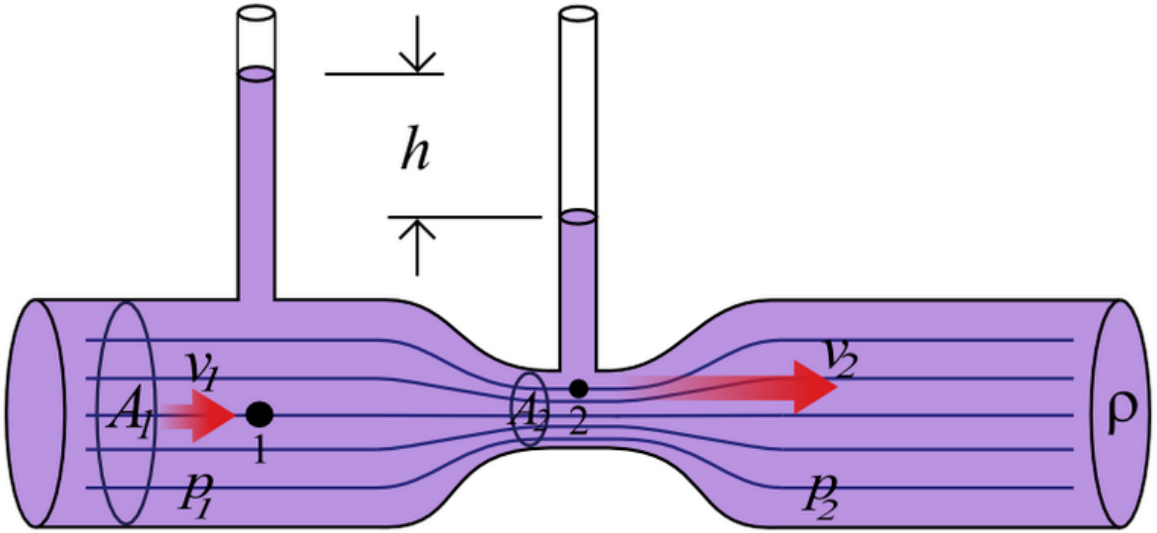
$$p_1 + \frac{1}{2}\rho v_1^2 + \rho y_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho y_2$$



Bernoulli's Equation

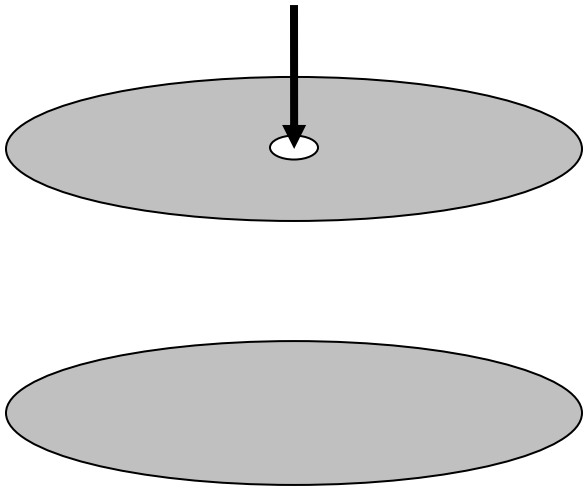
$$p_1 + \frac{1}{2}\rho v_1^2 + \rho y_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho y_2$$

- Consequences:
  - When the velocities are zero (static) we get back our pressure relationship with height.
  - When the heights are the same, note that higher velocities give lower pressures.



CPS 34-4

- One of the two plates of the demonstration has air flowing out of the center. What will happen when the two plates approach each other?



A) The air will blow them apart.

B) The air will suck them together.

C) Nothing, these demonstrations never work.

D) Not enough information to solve.

Demos