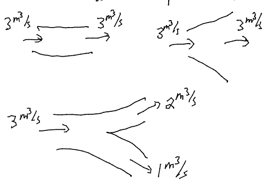
Flux : volume of fluid / s

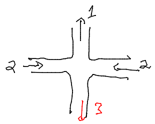
phi Φ

flux in = flux out

when steady flow

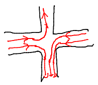
and incompressable fluid (ρ constant)





A) 1 ↓ c) 3 ↓ E) 5 ↓

B) 1 ↑ D) 3 ↑ F) 5 ↑



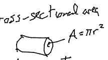
streamlines

- never start or stop (except boundaries)

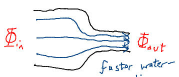
$$\Phi = A\,v$$

$$\frac{m^3}{s} = m^2\,\frac{m}{s}$$

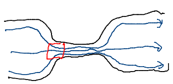
A : cross-sectional area

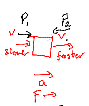


v : speed of water



As A gets smaller & Φ stays same, v gets bigger



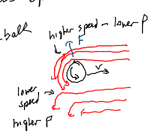


$P_1 > P_2$

Bernoulli's Principle

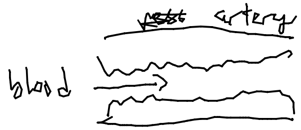
as speed increases, pressure decreases

curveball



airplane wing

how airplanes get off the ground



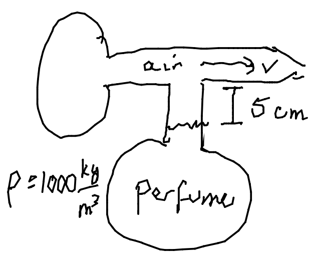
obstruction can slow blood down, increase pressure

Bernoulli's Equation

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

If one term is constant and second term decreases then third term increases by same amount

- As v increases, P decreases
- As h decreases, P increases



How fast must air go for perfume to reach it?

For perfume to rise, pressure of air has to drop by $\rho g(5\text{cm})$
$= 490\ \text{Pa}$

for air pressure to drop by $490\ \text{Pa}$,

$$490\ \text{Pa} = \frac{1}{2}\rho v^2$$

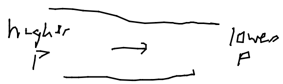
$$v^2 = \frac{2(490\ \text{Pa})}{(1.2\ \text{kg/m}^3)} \rightarrow v = 29\ \text{m/s}$$

- Viscosity

High viscosity - flows with difficulty

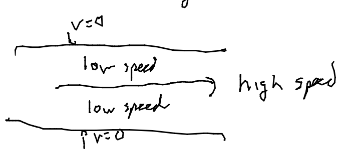
No viscosity - will flow through a pipe at constant speed forever

Viscous fluids need to be pushed or they will stop (friction)



$$\Delta P = 8\pi\eta \frac{L\, v_{avg}}{A}$$

- η : viscosity coefficient
- L : length of pipe
- A : cross-sectional area
- v_{avg} : average speed



Air $\eta = 1.8 \times 10^{-5}$ Pa-s

Water $\eta = 1.0 \times 10^{-3}$ Pa-s at 20°C

$= 0.7 \times 10^{-3}$ Pa-s at 40°C

depends on temperature

honey 15°C : $\eta = 600$

40°C : $\eta = 20$