

Water Distribution

Question:

Water enters your home plumbing at ground level. Where will you get the strongest spray from a shower?

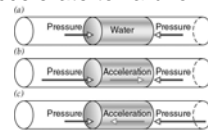
- In the ground floor shower
- In the basement shower
- In the second floor shower

Observations About Water Distribution

- Water is pressurized in the pipes
- Higher pressure water sprays harder
- Higher pressure water sprays higher
- Water is often stored up high

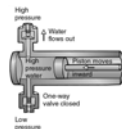
Fluid Motion (no gravity)

- Fluids obey Newton's laws
 - Net forces cause accelerations
 - Net forces are due to pressure imbalances
 - Fluids accelerate toward lowest pressures



Pressurizing Water

- To pressurize water,
 - use Newton's third law
 - push inward on the water
 - water pushes outward on you
 - water's outward push is due to its pressure
 - water pressure rises as you squeeze it



Pumping Water (no gravity)

- Squeeze water to raise its pressure
- Water accelerates toward lowest pressure
- Water begins flowing
- You do work on the water
 - You keep squeezing as water flows
 - Water moves in direction of your force
 - In this case: $Work = Pressure \cdot Volume$

Pressure Potential Energy

- Pumping water requires work
- Pumped water carries energy with it
- Energy isn't really stored, it's promised
 - but energy resembles a potential energy
 - so it's called pressure potential energy (PPE)
- PPE requires steady-state flow (SSF)

Energy Conservation (no gravity)

- In SSF through fixed obstacles, fluid's energy and energy/volume are constants
- Energy is PPE + KE (Kinetic Energy)
- Bernoulli's equation (no gravity):

$$\text{PPE} + \text{KE} = \text{Constant}$$

$$\text{PPE}/\text{Vol} + \text{KE}/\text{Vol} = \text{Constant}/\text{Vol}$$
 (along a streamline)

Fluid Motion (with gravity)

- Fluids obey Newton's laws
 - Weight contributes to net force
 - Weight creates pressure gradients
 - Pressure decreases with altitude
 - Pressure increases with depth
 - Fluids have gravitational potential energy (GPE)



Energy Conservation (with gravity)

- Energy is PPE + KE + GPE
- Bernoulli's equation:

$$\text{PPE} + \text{KE} + \text{GPE} = \text{Constant}$$

$$\text{PPE}/\text{Vol} + \text{KE}/\text{Vol} + \text{GPE}/\text{Vol} = \text{Constant}/\text{Vol}$$
 (along a streamline)

Question:

Water enters your home plumbing at ground level. Where will you get the most intense shower spray?

- In the ground floor shower
- In the basement shower
- In the second floor shower

Summary About Water Distribution

- Water's energy is conserved during SSF
- Water's energy changes form in pipes
- Pressure drops as water's height or speed rise
- Storing water up high gives it higher energy

