

FLUID DYNAMICS

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FLUIDS

WHAT IS A FLUID?

What do you think are some fluids?

- Water
- Liquids

“A substance, as a liquid or gas, that is capable of flowing and that changes its shape at a steady rate when acted upon by a force tending to change its shape”

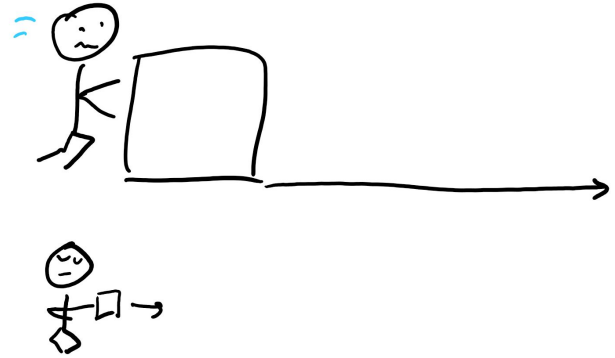
– Merriam Webster

- Gases are fluids?
- Anything that changes its shape at a steady rate due to forces

ENERGY

HOW TO CALCULATE ENERGY?

- Work is force times distance.
- I get more tired pushing a box with more “force.”
- I get more tired pushing a box further.
- Energy is the ability to do “work.”

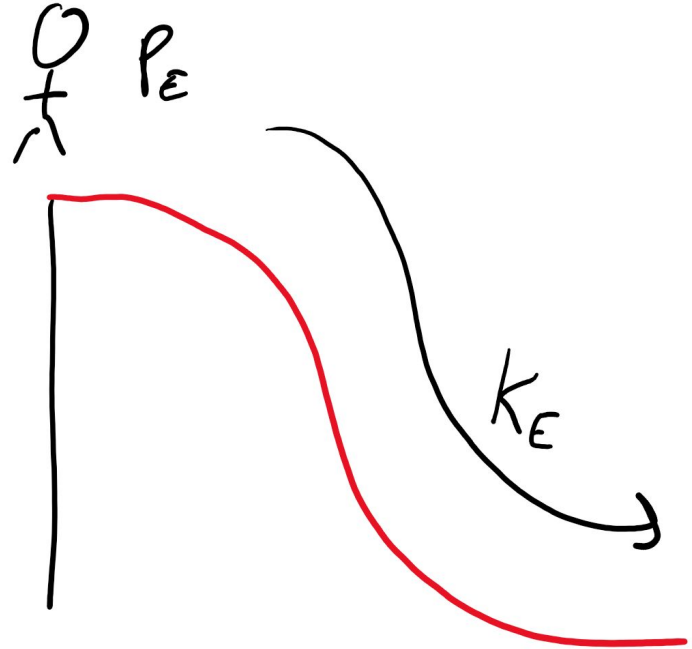


TWO TYPES OF ENERGY

Potential energy

Kinetic energy

Now guess what they mean!



GOOD GUESSES BUT YOU'RE WRONG (UNLESS SOMEONE GOT IT RIGHT, THEN I LOOK DUM)

Kinetic: Has to do with motion. When objects are zoomin-zoomin, they have Kinetic Energy.

Potential: Energy based on position. Gives objects the “potential” to move.

Me on top of a slide has “potential” energy because I have the opportunity to jump down the stairs leading up to the slide and fall speedily to the ground (“kinetic” energy).

SPOOPY EQUATIONS

Don't memorize, too hard

Just keep them in mind, or
write them down for reference

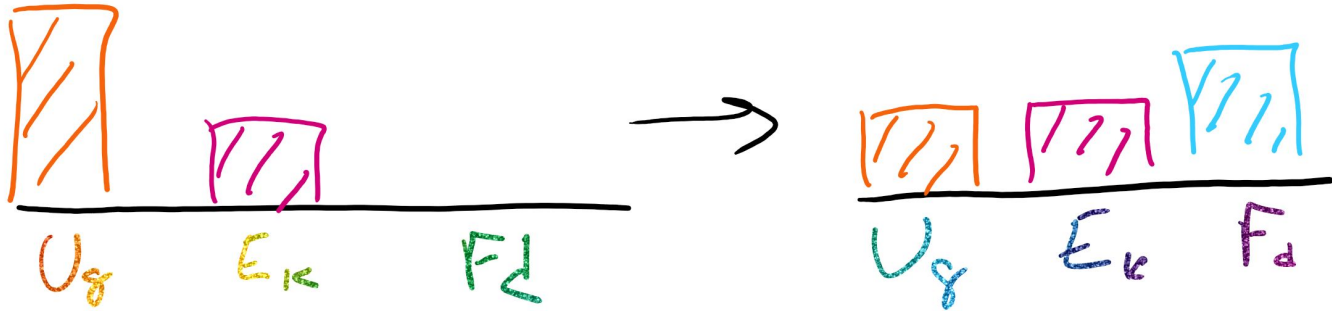
$$U_g = \underbrace{mg}_{F} \underbrace{h}_{d}$$

$$E_k = \frac{1}{2} m v^2$$

ENERGY IS CONSERVED

If we start with some amount of energy, we end up with the same amount of energy, even though the type of energy can change.

$$U_{g1} + E_{k1} + F_1 \cdot d_1 = U_{g2} + E_{k2} + F_2 \cdot d_2$$



PRESSURE

PRESSURE ON FLUIDS

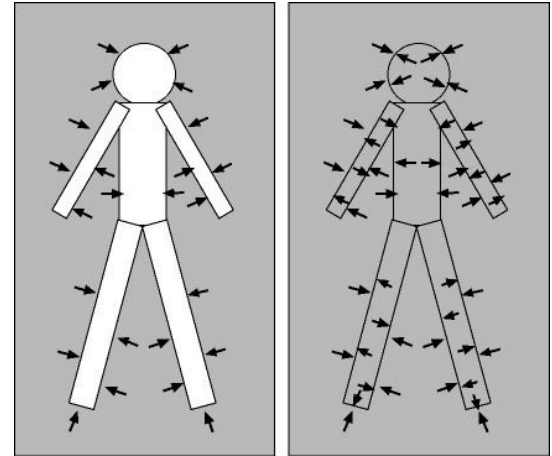
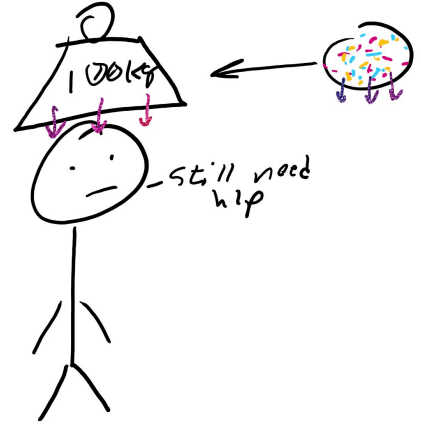
Pressure: How much force per unit area on a fluid

- F/A (Force divided by Area)
- Liquids are “incompressible”
 - Like, try to squeeze water, I dare you; you can't see, boom, proven
- Pressurized CO₂ in a can of soda/pop/coke/however you want to say it



PRESSURE AND DEPTH

- Pressure can be caused by particles above (bc they push down on u)
- Your body is facing pressure from the air all the way from your shoulders to the sky
- Why are we not crushed?
 - We have air in our bodies that counteract this with its own pressure, so there is no pressure difference
- Only pressure DIFFERENCES can causes force

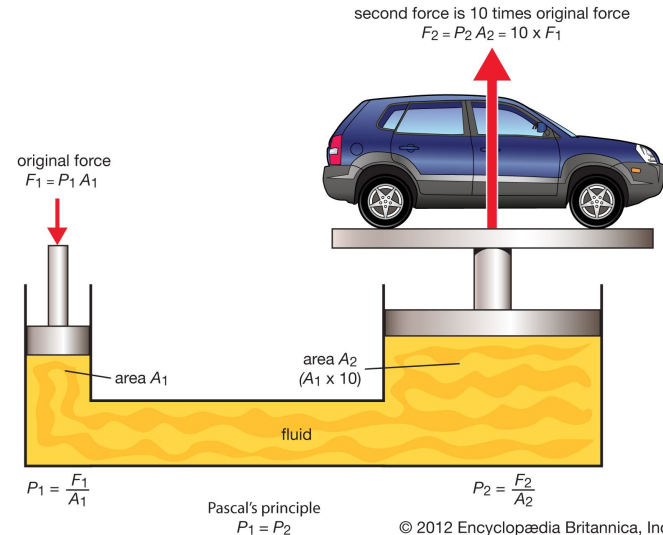


PASCAL'S PRINCIPLE

- “A change in pressure at any point in an enclosed fluid at rest is transmitted undiminished to all points in the fluid”

What does it mean?

- If we have a pool of water and increase the pressure air exerts on the water, the water everywhere will increase in pressure



REVIEW

Is air a fluid? Why or why not?

What are a couple of properties of fluids?

Why don't our bodies get crushed under atmospheric pressure?

Why do hydraulic lifts work?

BERNOULLI'S LAW

BERNOULLI'S LAW

$$P_1 + \frac{1}{2}\rho V_1^2 + \rho gh_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho gh_2$$

So, what does this mean?

- Second term is “kinetic energy”
- Third term is “potential energy”
- Pressure is first term
- Pressure plus kinetic energy plus potential energy is constant

IN TERMS WE CAN UNDERSTAND

Multiply every term by volume!

$$F_1 d_1 + \frac{1}{2} m v_1^2 + m g h_1$$

=

$$F_2 d_2 + \frac{1}{2} m v_2^2 + m g h_2$$

ENERGY AND PRESSURE

The more energy, potential and kinetic, the less pressure

- Take two empty soda cans
- Blow between them, they will get closer

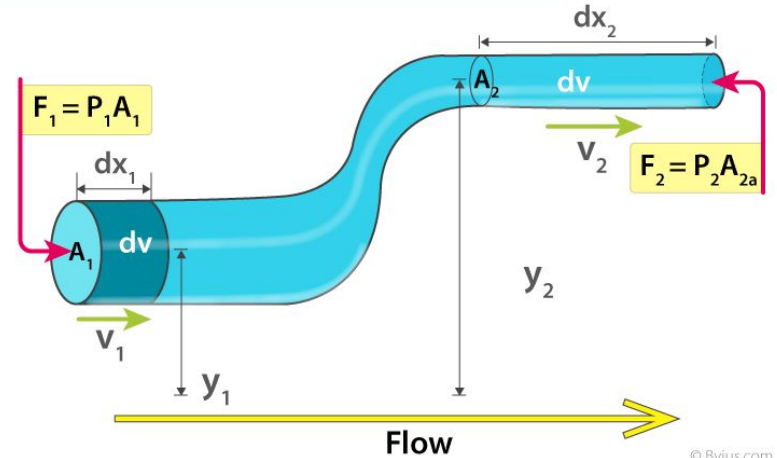
Why?

- Higher speed means more kinetic energy
- More kinetic energy means less pressure
- Cans move toward low pressure zones

THE POTENTIAL ENERGY EXAMPLE

Pipes with a differing thickness and heights

- Velocity and this KE increases due to decreased size
- PE increases due to height increase
- Pressure is especially low



THE PRINCIPLE

Bernoulli's principle states that an increase in the speed of a fluid occurs simultaneously with a decrease in static pressure or a decrease in the fluid's potential energy

- “Fast moving air creates spots of low pressure”
- Like we said earlier, the trade off for more energy is pressure
- Water towers?



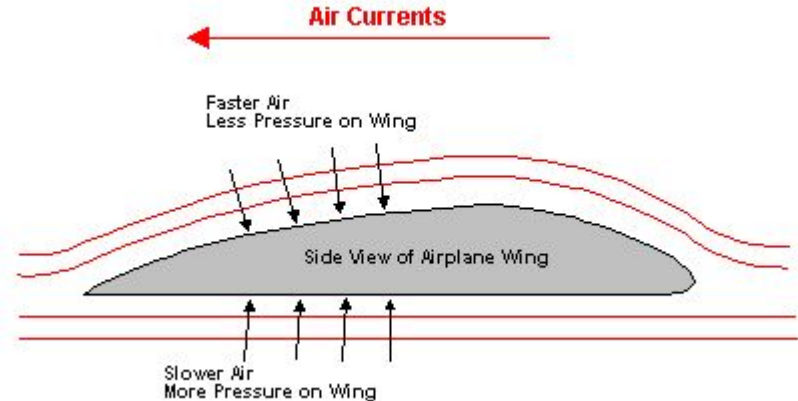
APPLICATIONS

Drafting

- You can “feel” someone else's draft since the high velocity air behind them makes it low pressure by Bernoulli's

Airplanes?

- You may have heard Bernoulli's causes air planes to fly but that is a lie

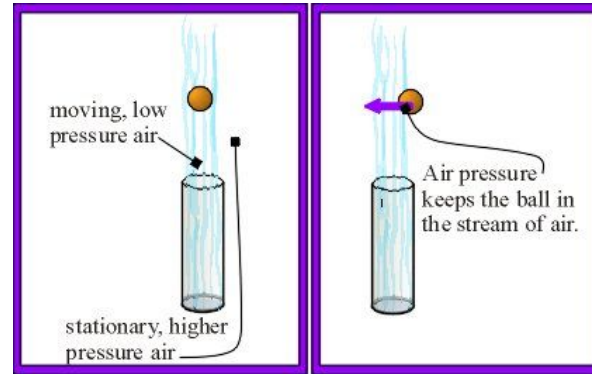


FLOATING PING PONG BALL?

With Bernoulli's you can get a floating ping pong ball in your own room!

Materials:

- One Ping Pong Ball
- One Hair Dryer



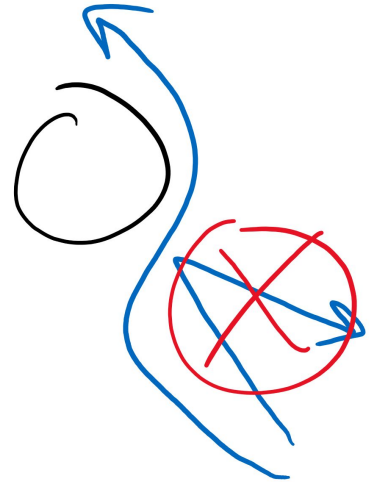
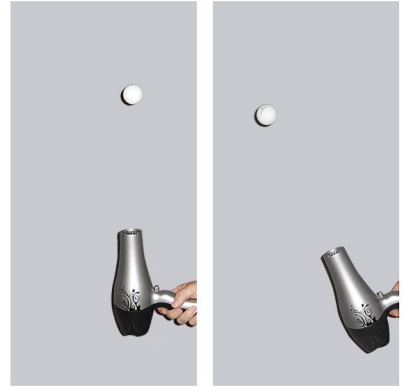
Open the hair dryer and set the Ping Pong ball in the center of it! The hair dryer speeds the air up increasing the energy, and thus dropping the pressure, forcing the ball into the hair dryer air.

WHY DO DA AIR DO DA STICK?

Wait if the air is “pushing” on the ball, if I tilt my hairdryer to the left, the ball should fall off right?

Heck no. If you’ve been to the Science Museum, there’s a giant hairdryer thingy for balls, and you can tilt that all you want and the ball still doesn’t fall off the hairdryer.

This is called the “Coanda effect”



REVIEW

What does Bernoulli's Principle say?

What are some of its uses?

Does the speed of a fluid affect pressure?

Does a height change increase affect pressure?