Altitude

Pressure, Density, Above Sea Level. . .

Made by Michael Tet.

Why is it so hard to measure?

Know your altitude = don't hit mountains (important)!

How can we measure it at all?

Let's start with a simple hot air balloon:

We begin by hanging a large yardstick off the edge of our balloon as shown. Using this technique.

We touch our yardstick to the ground and measure our distance from the grass/water below us.

Knowing our altitude **Above Ground Level** (AGL) is great, but *we cannot fly around with a large stick hanging from our aircraft!*

Understanding Pressure

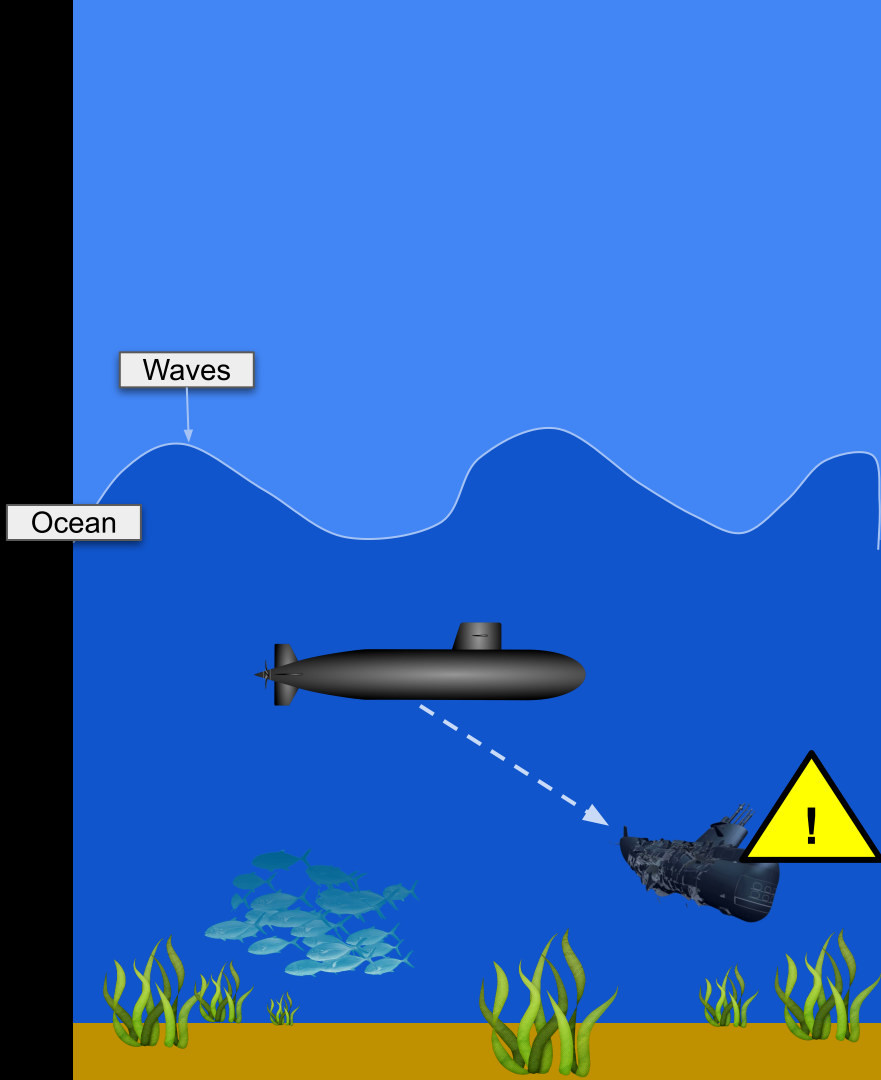
Consider the submarine: Why can it not descend too deep?
“Of course”, you say, “it will be crushed!”

That’s true, the submarine *will* get crushed. But why?

Because of *PRESSURE*.

The WEIGHT of the water above it will smush the submarine, and it will implode!

This “weight” that the submarine would feel, we call <u>Pressure</u>

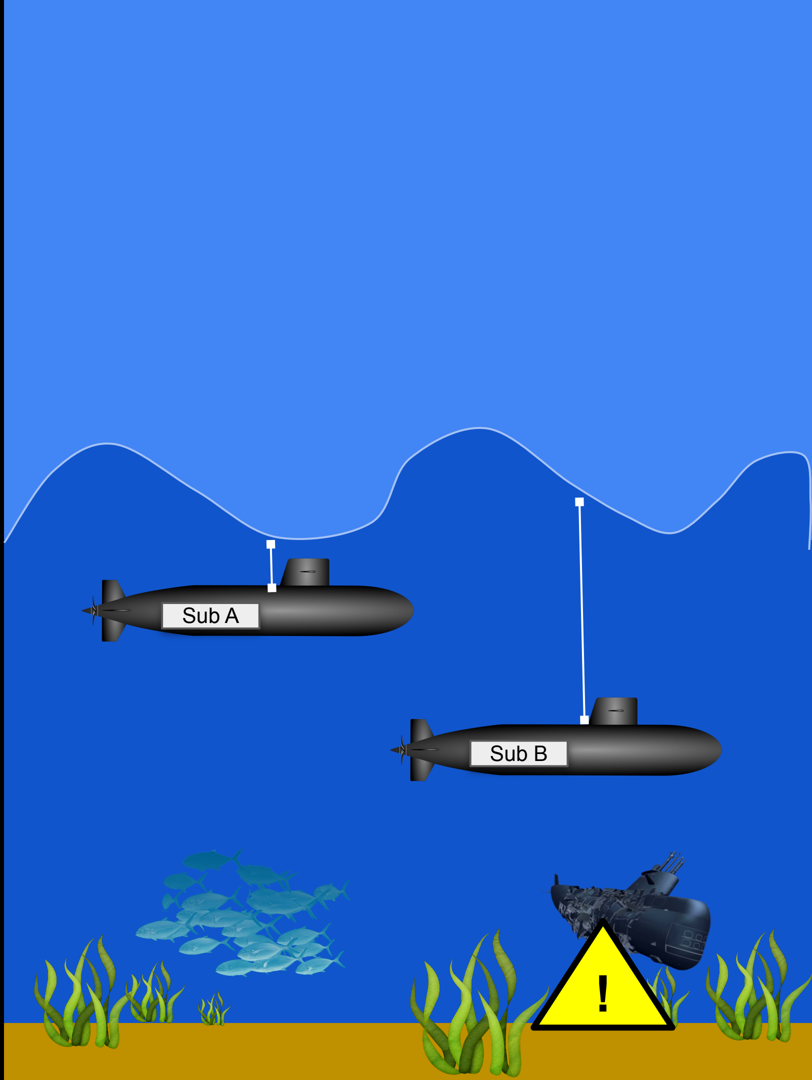


Understanding Pressure

Compare the two submarines.

Submarine A has a small distance below the water, therefore less water "weight" (we know this is called pressure), crushing it.

Comparatively, Submarine B has a large distance below the water, and therefore MORE pressure trying to crush it!



Pressure, the superior way to measure altitude

The Atmosphere is <u>JUST LIKE THE OCEAN!</u>

Look at how we can measure the pressure, or "weight" of the AIR just like we did with the submarines.

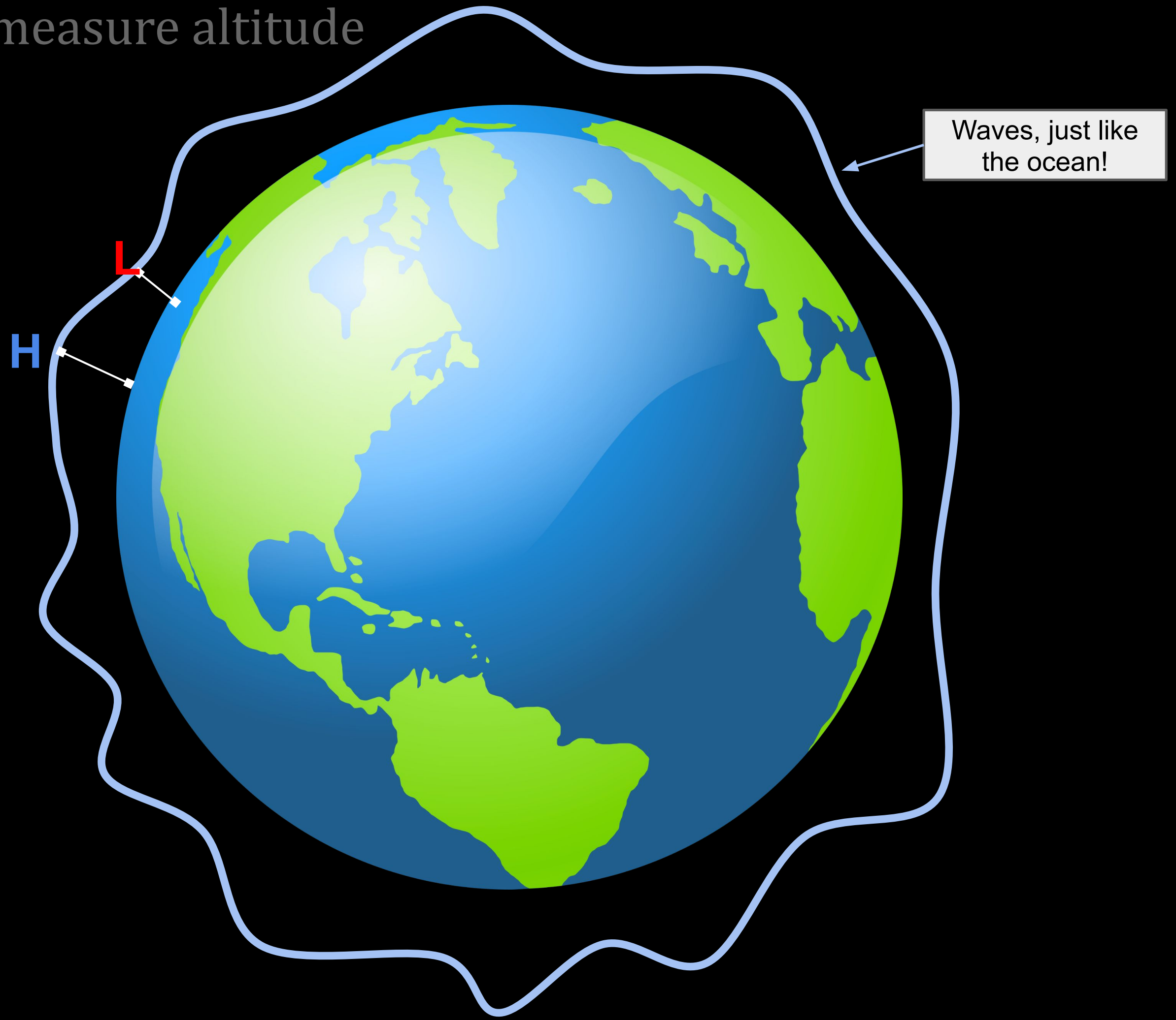
H - is used to signify an area of more weight to "push down" on us.

L - is used to signify an area of less weight to "push down" on us.

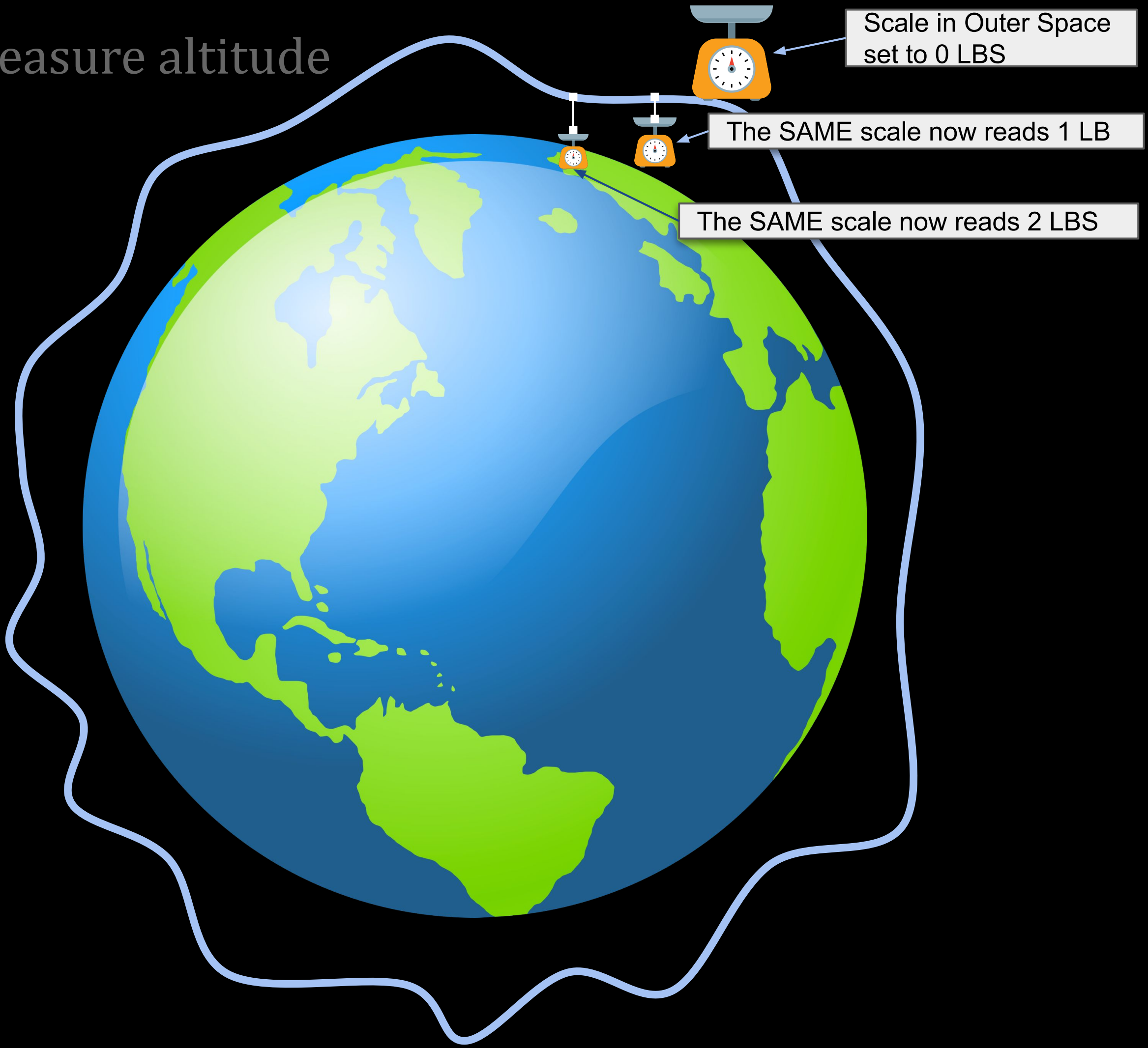
We call "**H**" a **High** Pressure Area

We call "**L**" a **Low** Pressure Area

Note: this High and Low pressure theory is very important in meteorology!!



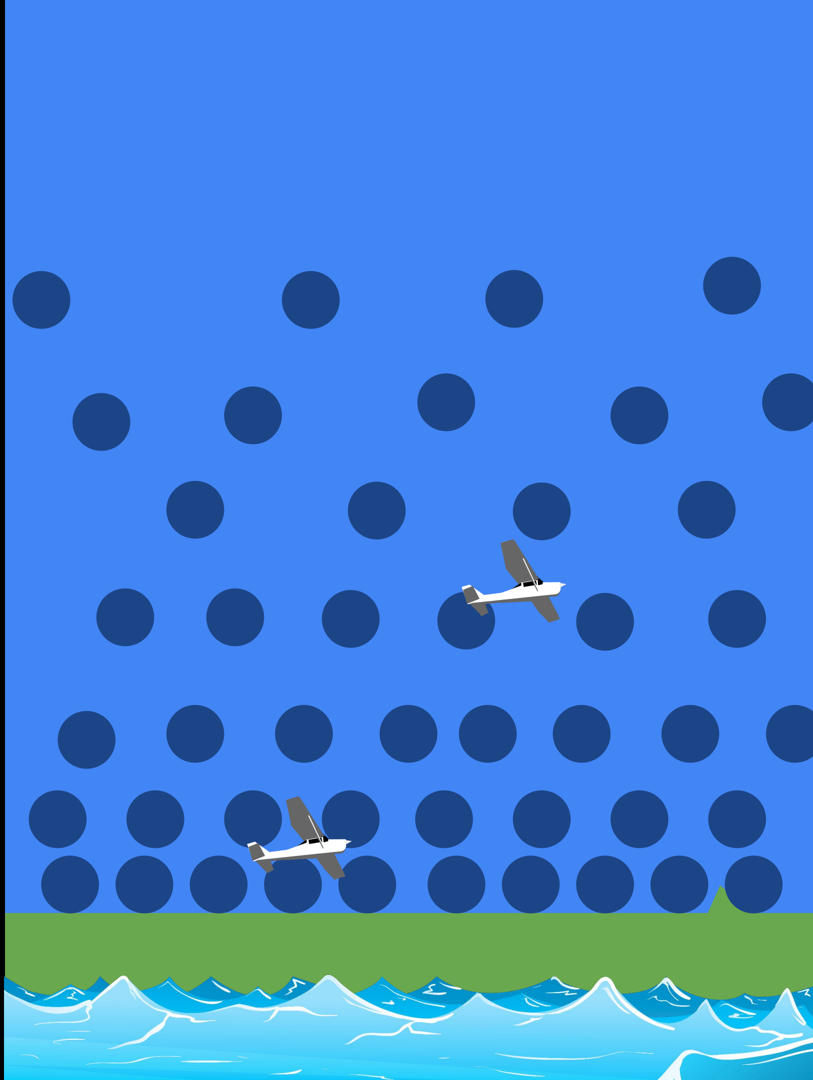
Pressure, the superior way to measure altitude



Pressure, the superior way to measure altitude

The Ocean and the Sky share this behavior of "pressure". Now, we *won't* crush our airplane by flying too low, but we *can* measure the change in "weight" as we climb and descend!

This *Change in "air weight", or <u>pressure</u> can indicate our altitude!*



Now let's look at the *PRESSURE,* or, *WEIGHT* of air!

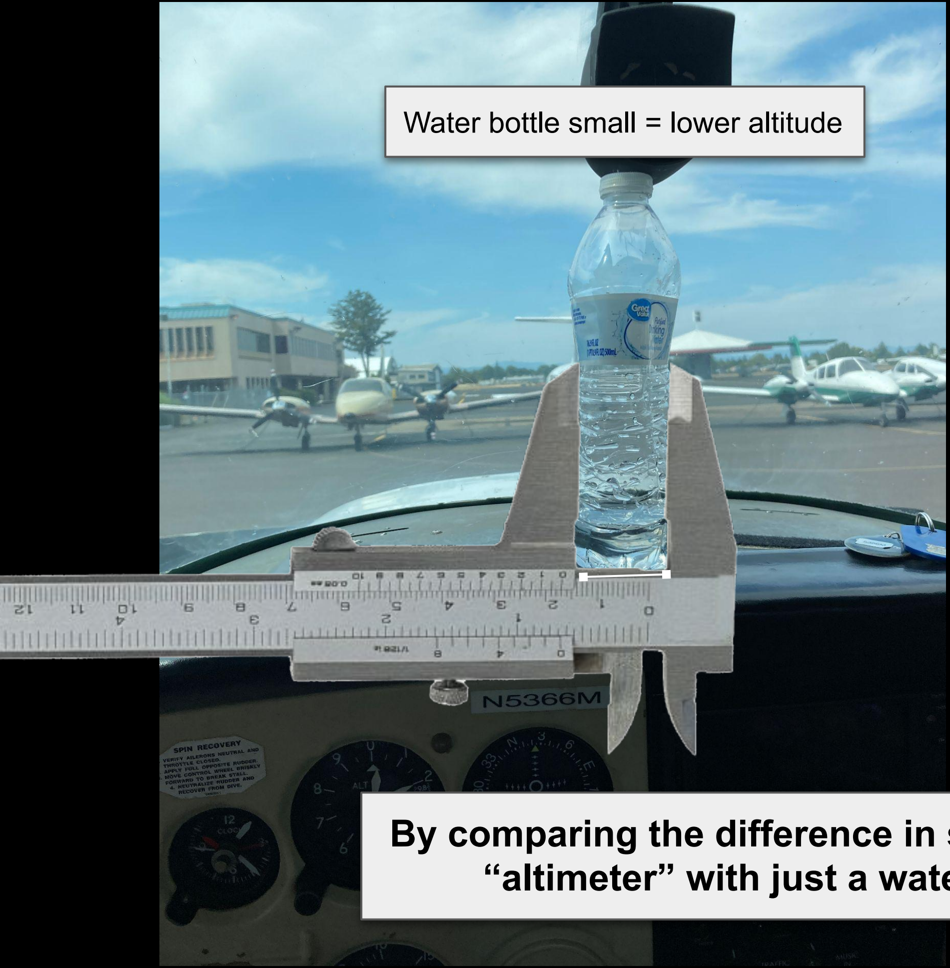
Low Altitude
(200ft MSL)

High Altitude
(10,000ft MSL)

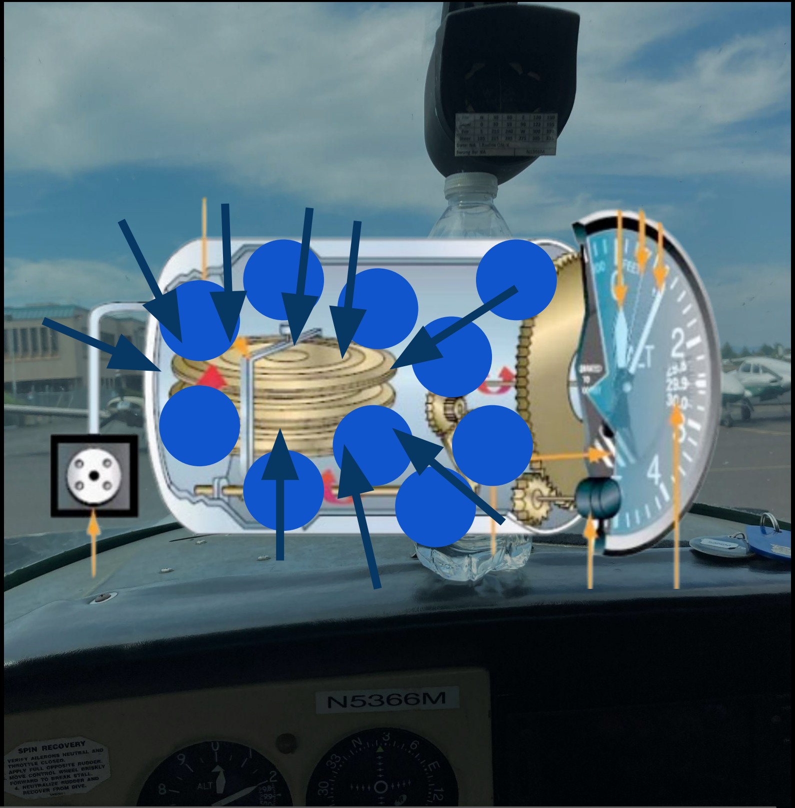
At low altitude, lots of air molecules squash this water bottle, as seen.

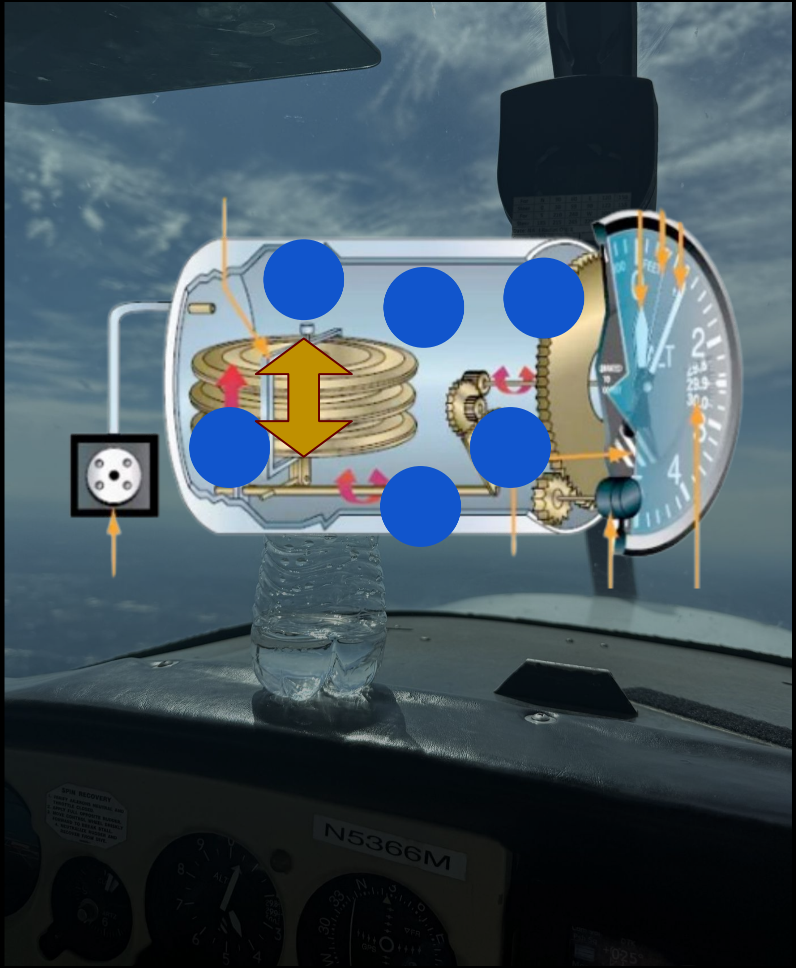
At high altitude, there's not so many air molecules to squash the water bottle, so it is free to expand, and it does!!

Now let's look at the *PRESSURE,* or, *WEIGHT* of air!



By comparing the difference in size, we have made a homemade "altimeter" with just a water bottle and some calipers!





At low altitude, lots of air molecules squash this altimeters' diaphragm, as seen. This causes it to shrink in size, and through mechanical linkages: indicate a lower altitude

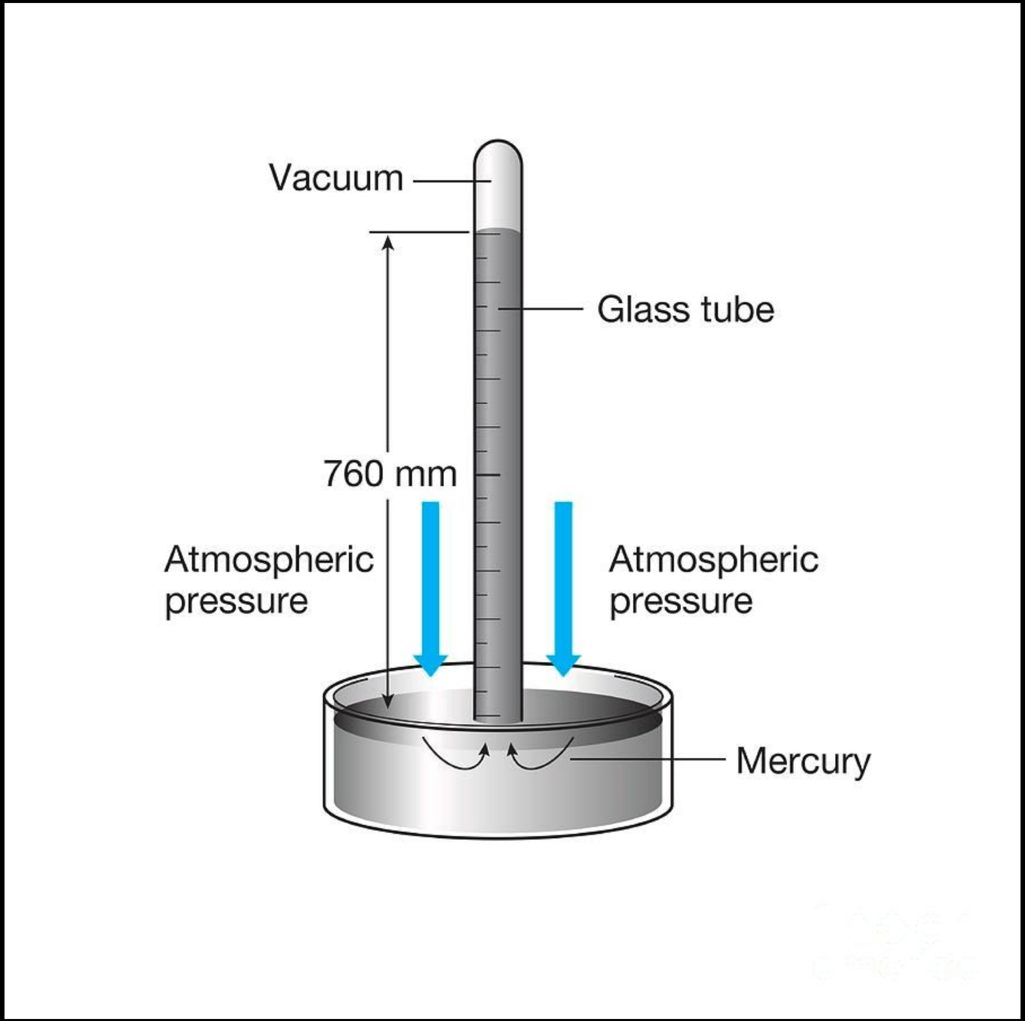
Barometer

Greek *"baros"* = weight
Greek *"metron"* = measure

Weight-measurer

Weight of the air-instrument!

THIS IS USED TO MEASURE AIR PRESSURE



Atmosphere similar to ocean. Always Flowing.

Inside our aneroid wafer, how much air is trapped?
29.92 inches of mercury → that's how much air is inside

Since we are measuring *COMPARED TO 29.92,* our altimeter will read our altitude *FROM* wherever 29.92 in. hg. Of air pressure exists!

WE WANT TO KNOW: our height above sea level

OUR ALTIMETER WILL TELL US: our height above *29.92*!

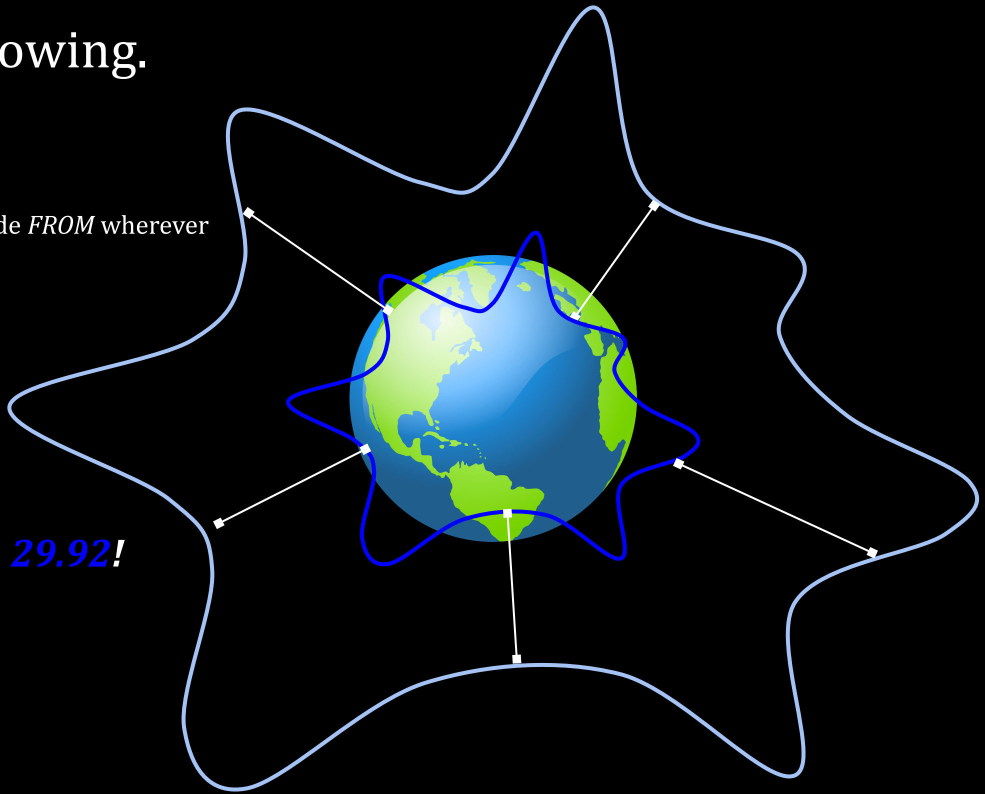


image not to scale

Why do we change altimeter settings?

Location A: 29.92 also at sea level!

In the Vicinity of location A: altimeter will read our height over sea level!

Location B: 29.92 is *BELOW* sea level! Our altimeter only reads our height above **29.92**, therefore not showing us our height MSL.

Why do we change altimeter settings?

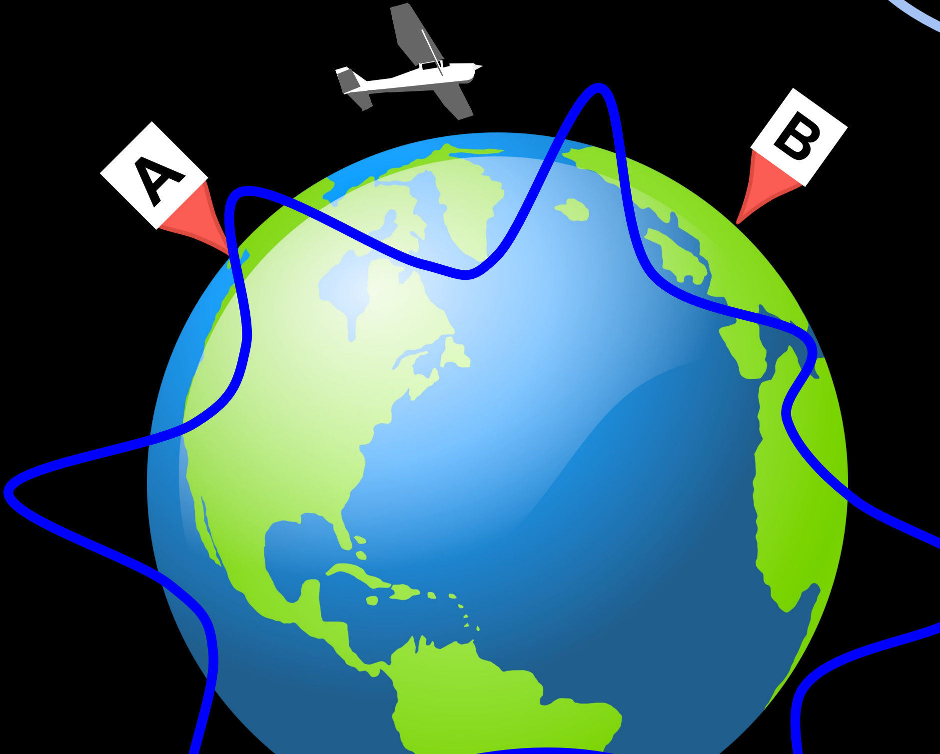
We trim level over "A", heading towards location "B"

FALL ASLEEP!

Why do we change altimeter settings?

WAKE UP!

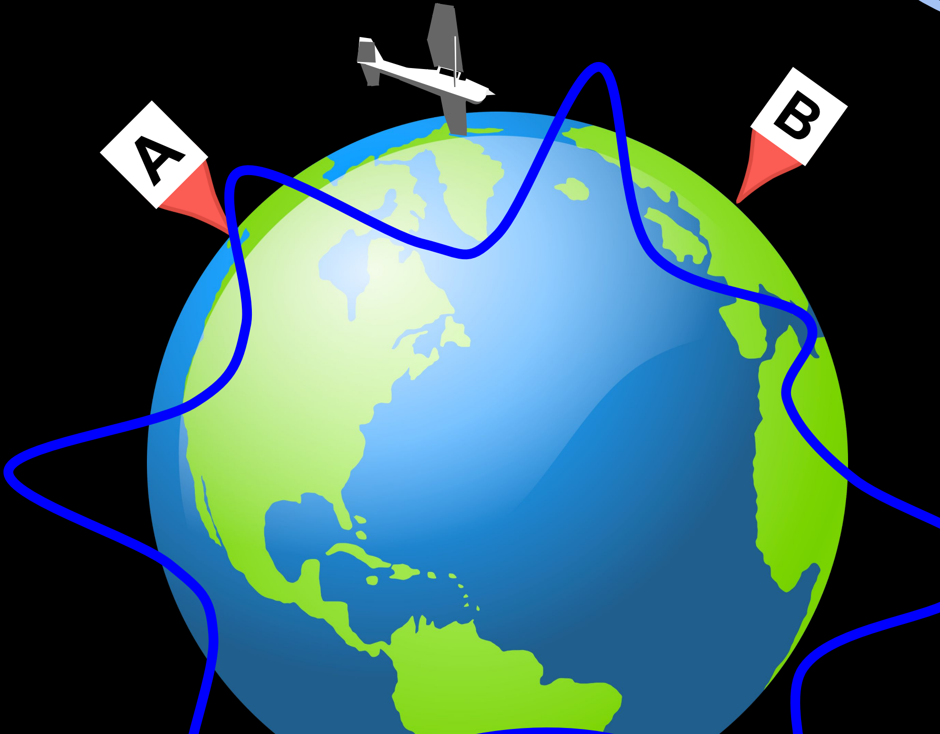
What does our altimeter indicate?



Why do we change altimeter settings?

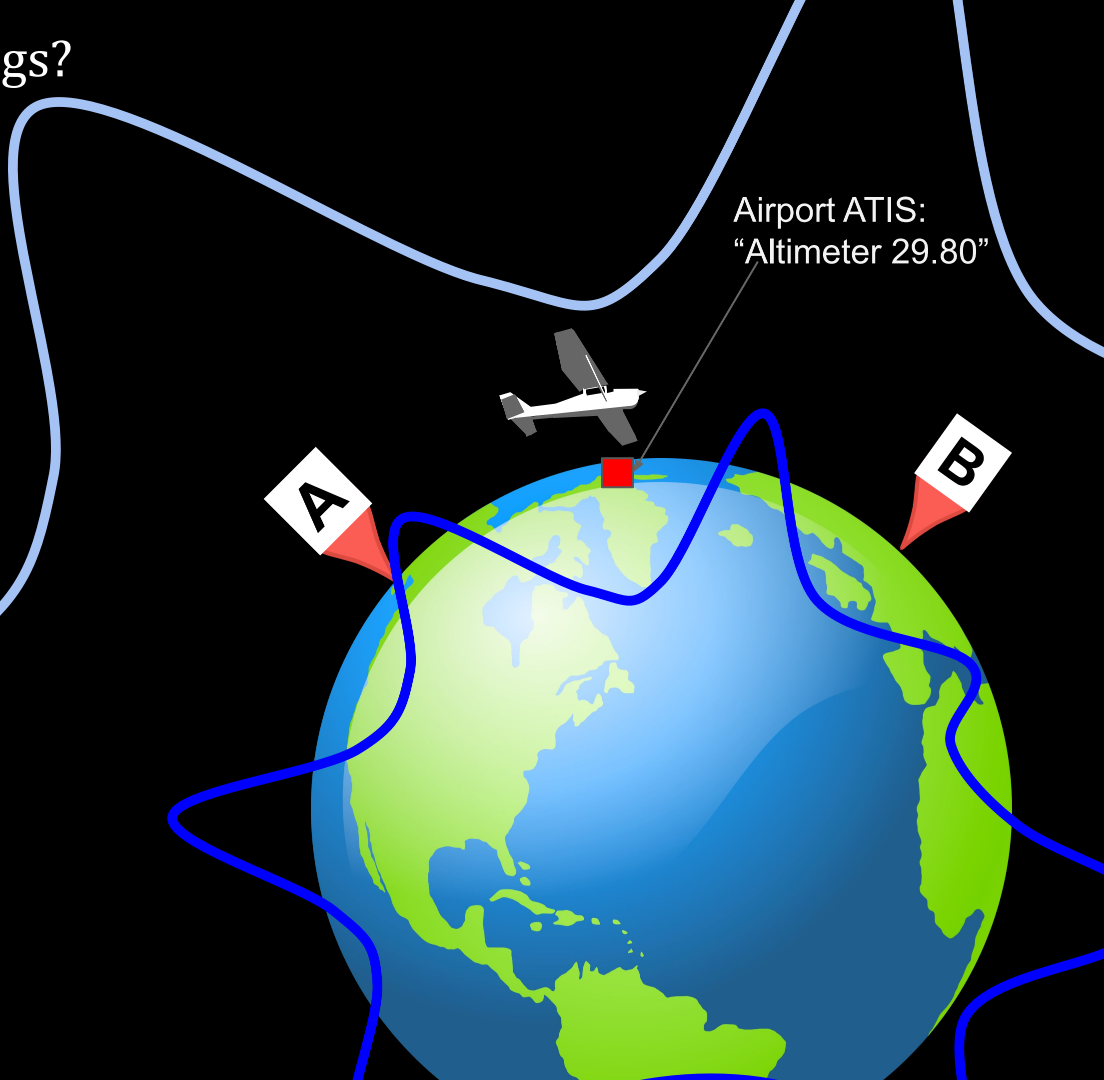
What does our altimeter indicate?

How does the pilot react to seeing this altitude?



Why do we change altimeter settings?

Instead of pushing nose down, we need to set our altimeter!



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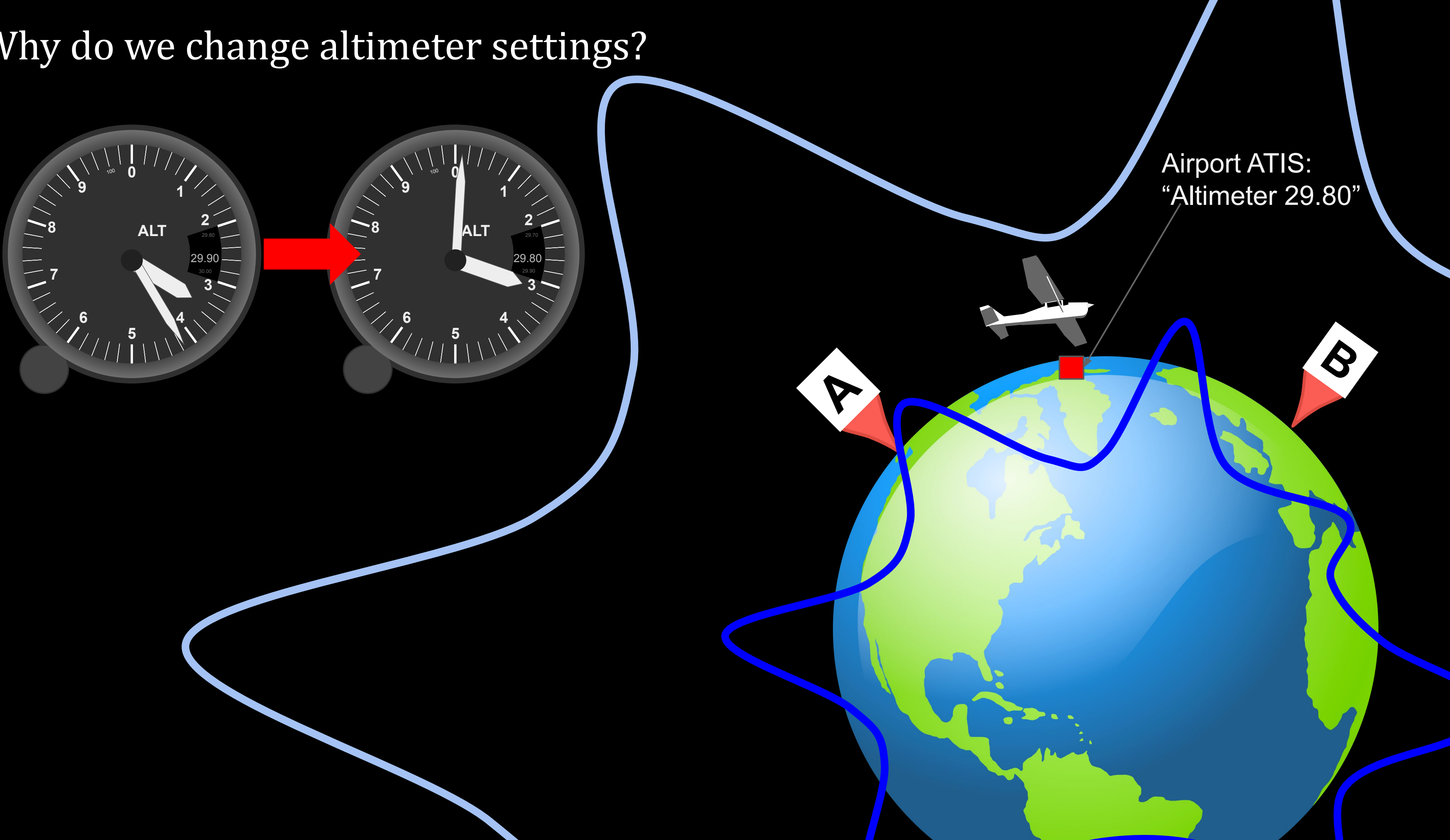

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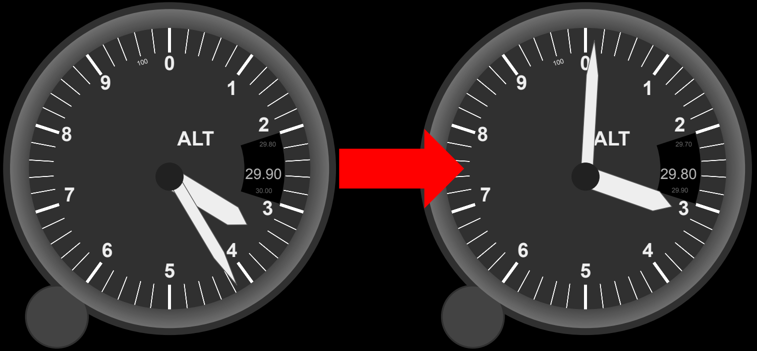
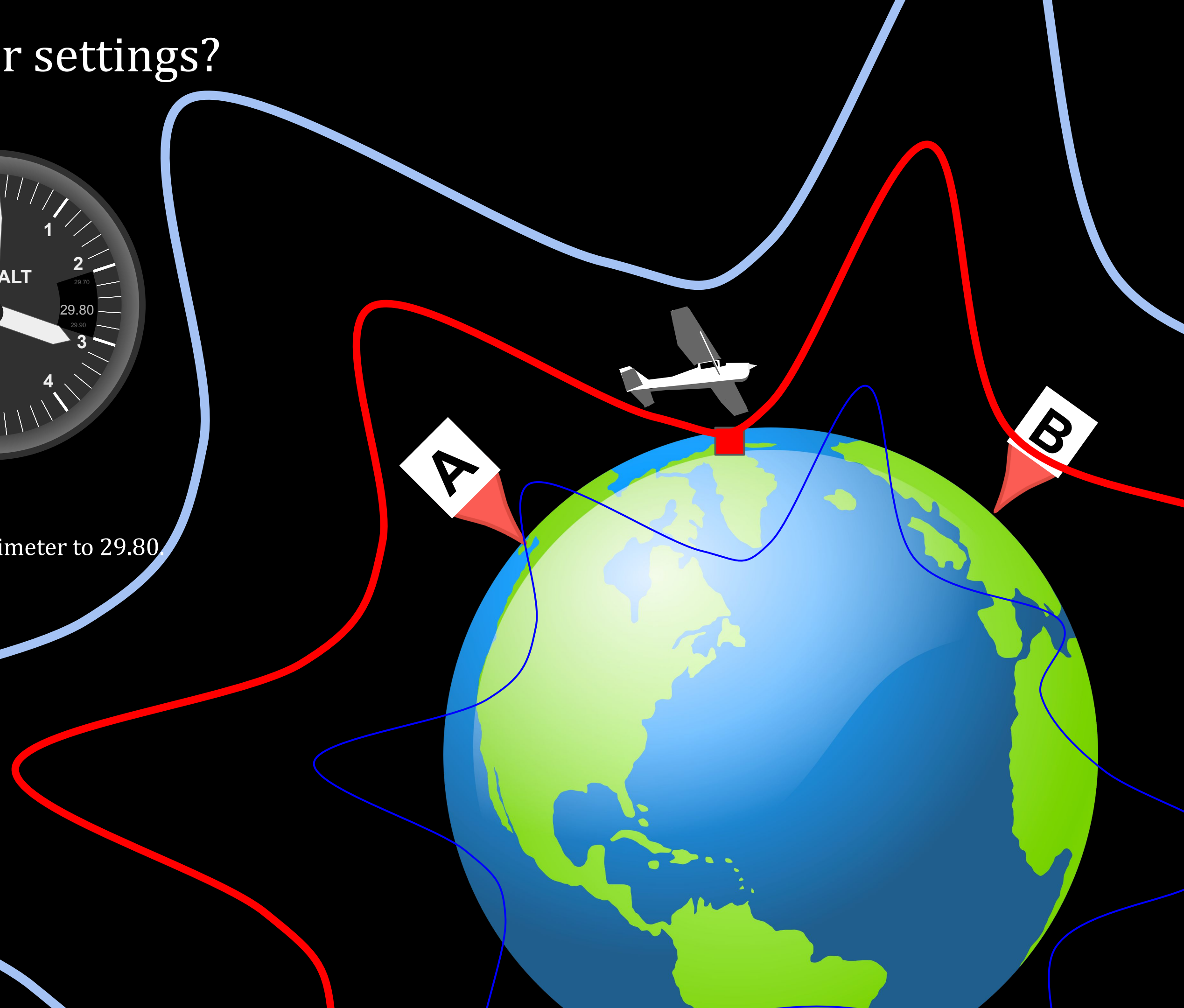


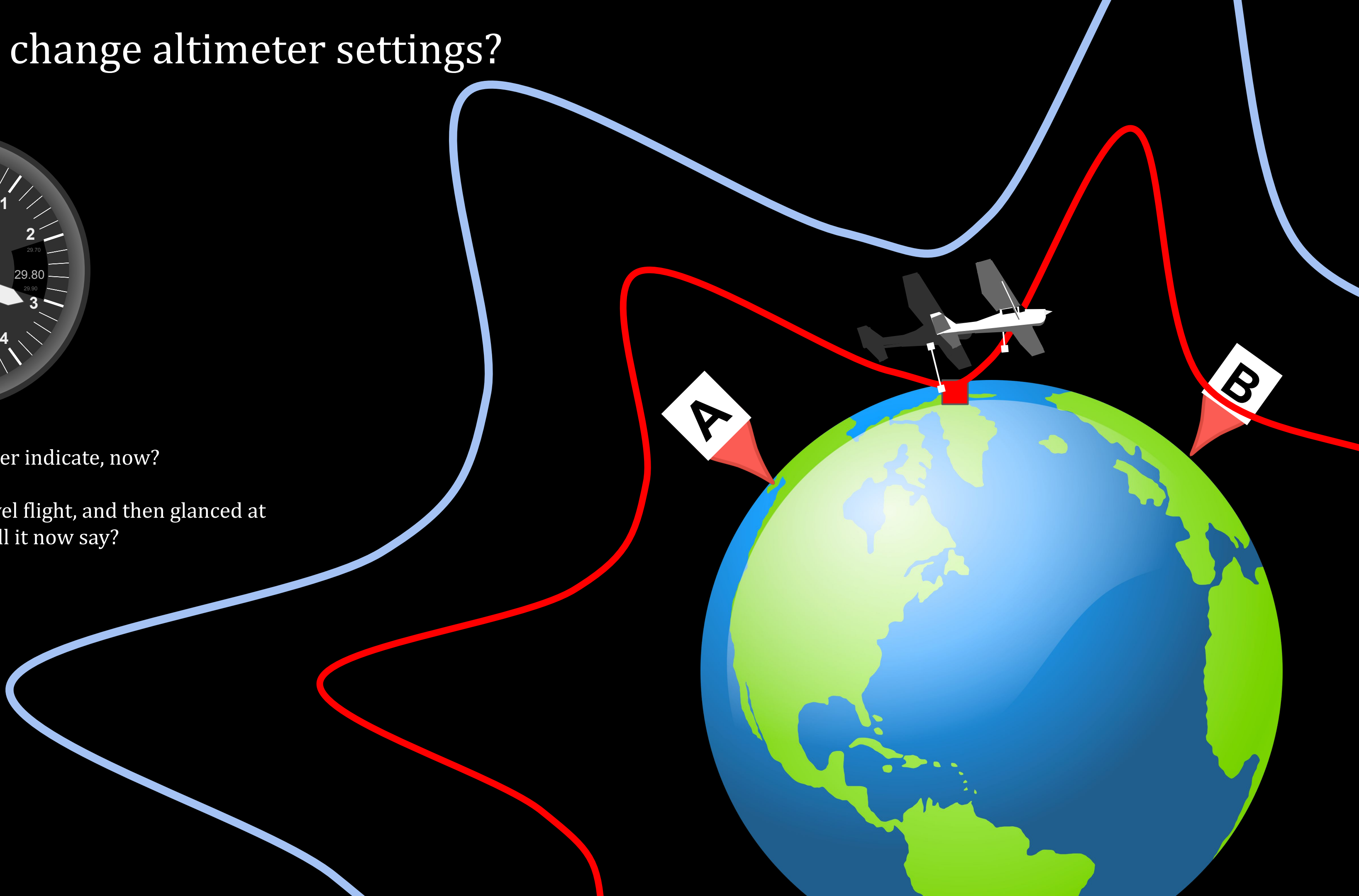
At the Red Airport, 29.80 is at sea level!

Since we are nearby Red airport, we need to set our altimeter to 29.80.

Now that our altimeter is set:
Our altimeter will measure height above the ***red* 29.80**

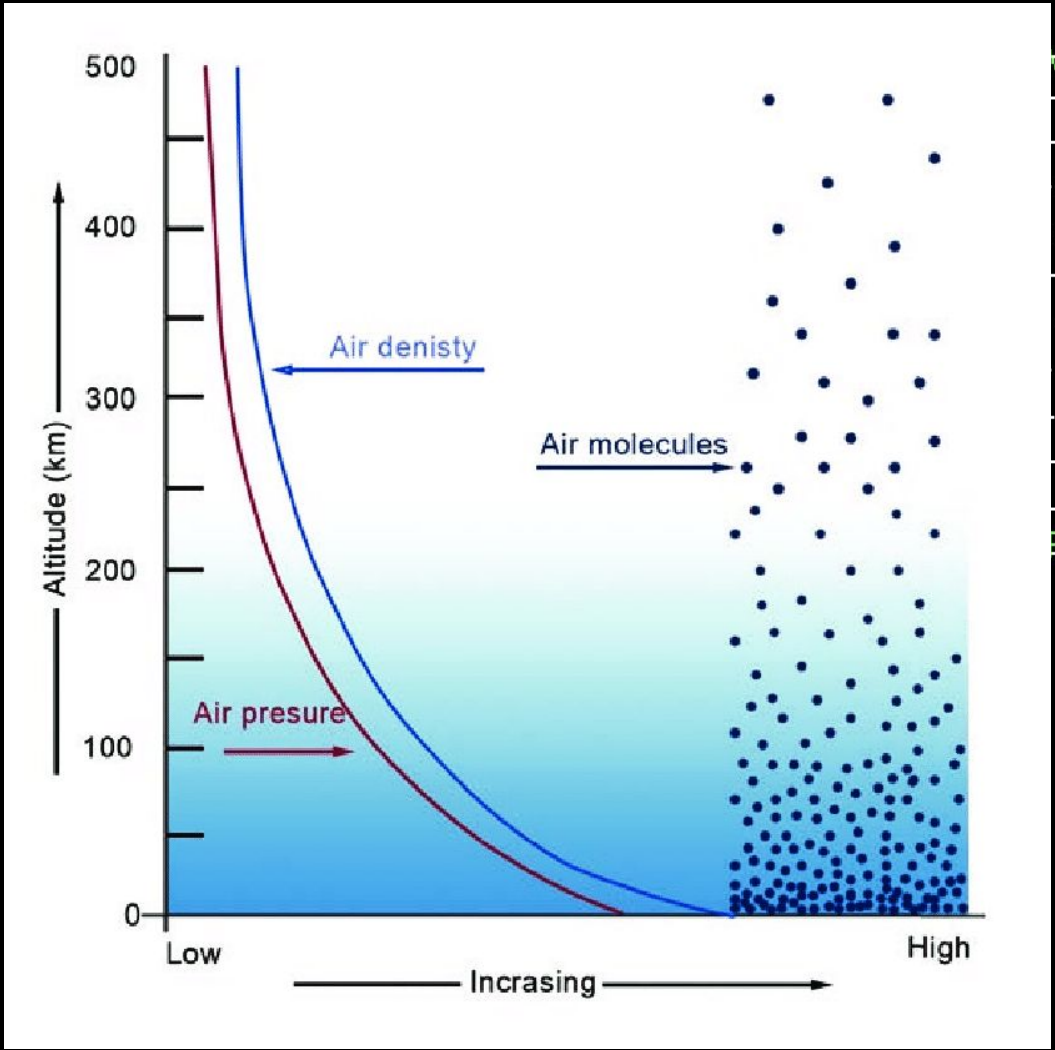


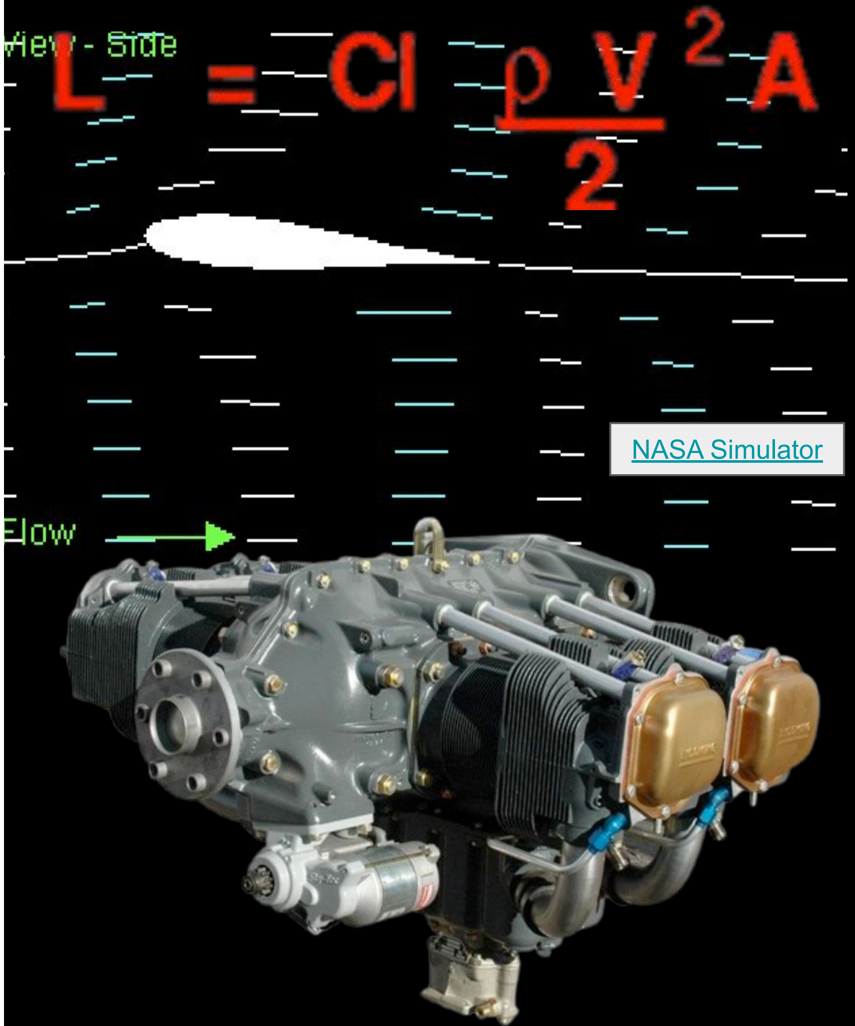
Why do we change altimeter settings?



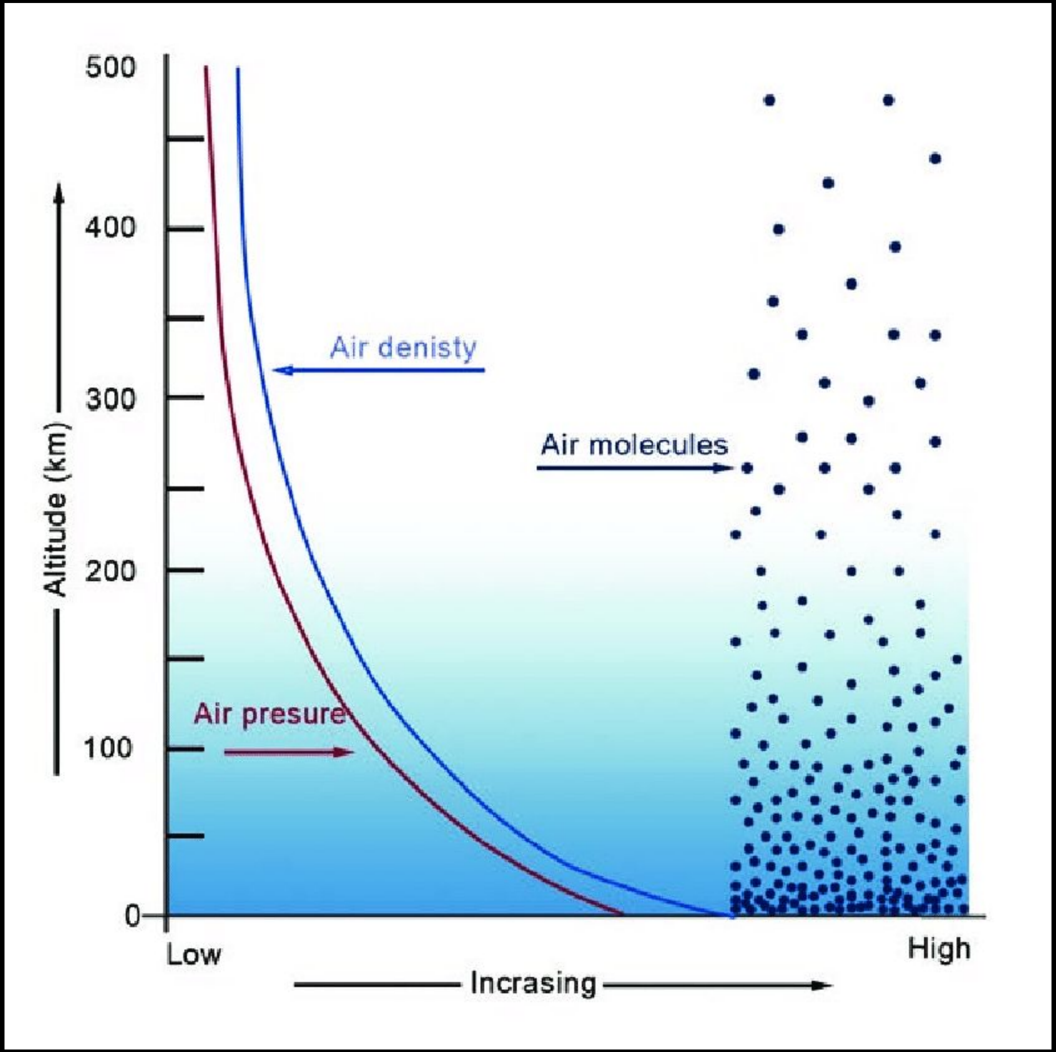
What does our altimeter indicate, now?

If we kept constant level flight, and then glanced at our altimeter, what will it now say?





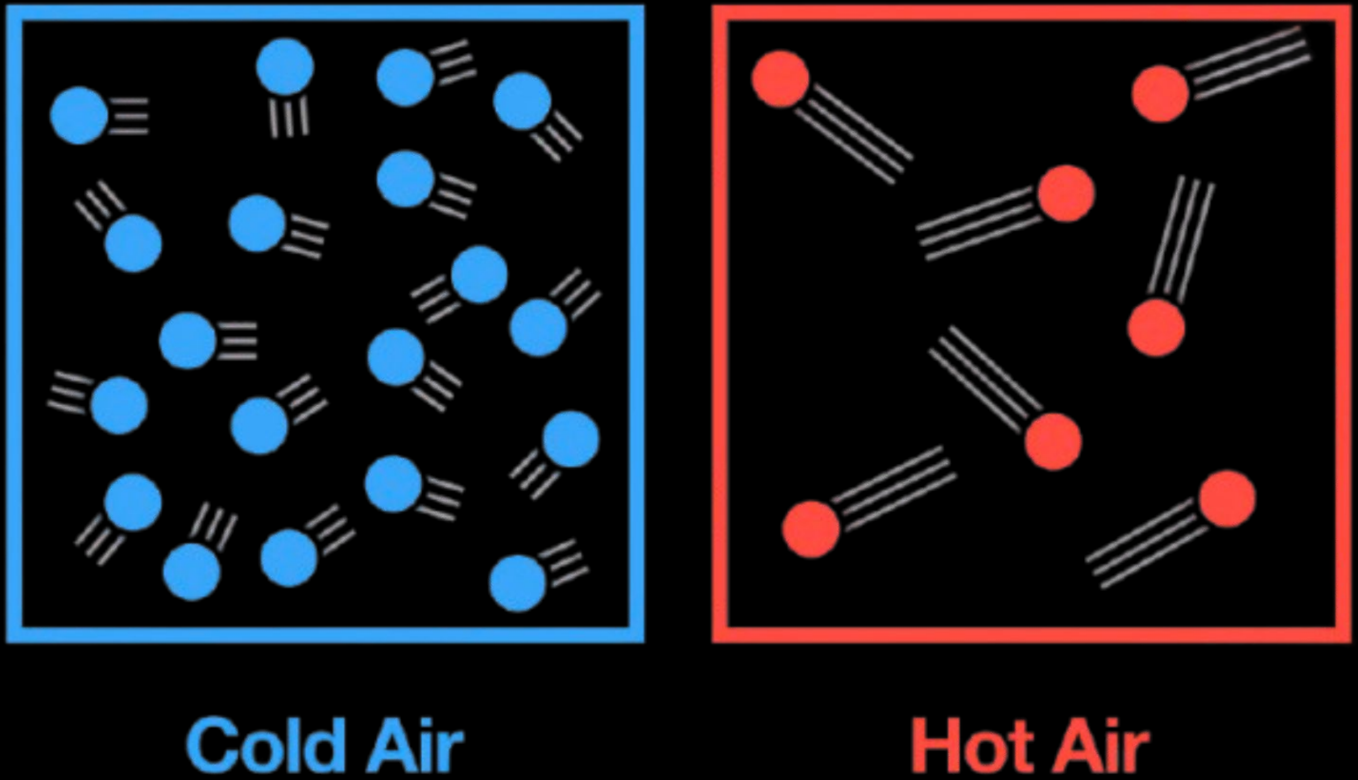
NASA Simulator



1. **Oxygen**
2. Fuel
3. Heat

What changes air density?

1. Air Pressure
2. **Temperature**
3. Humidity



What changes air density?

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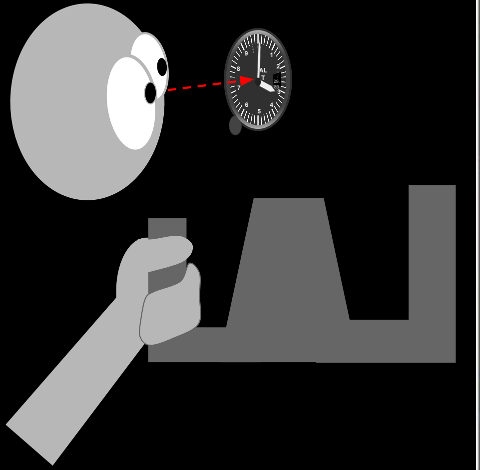


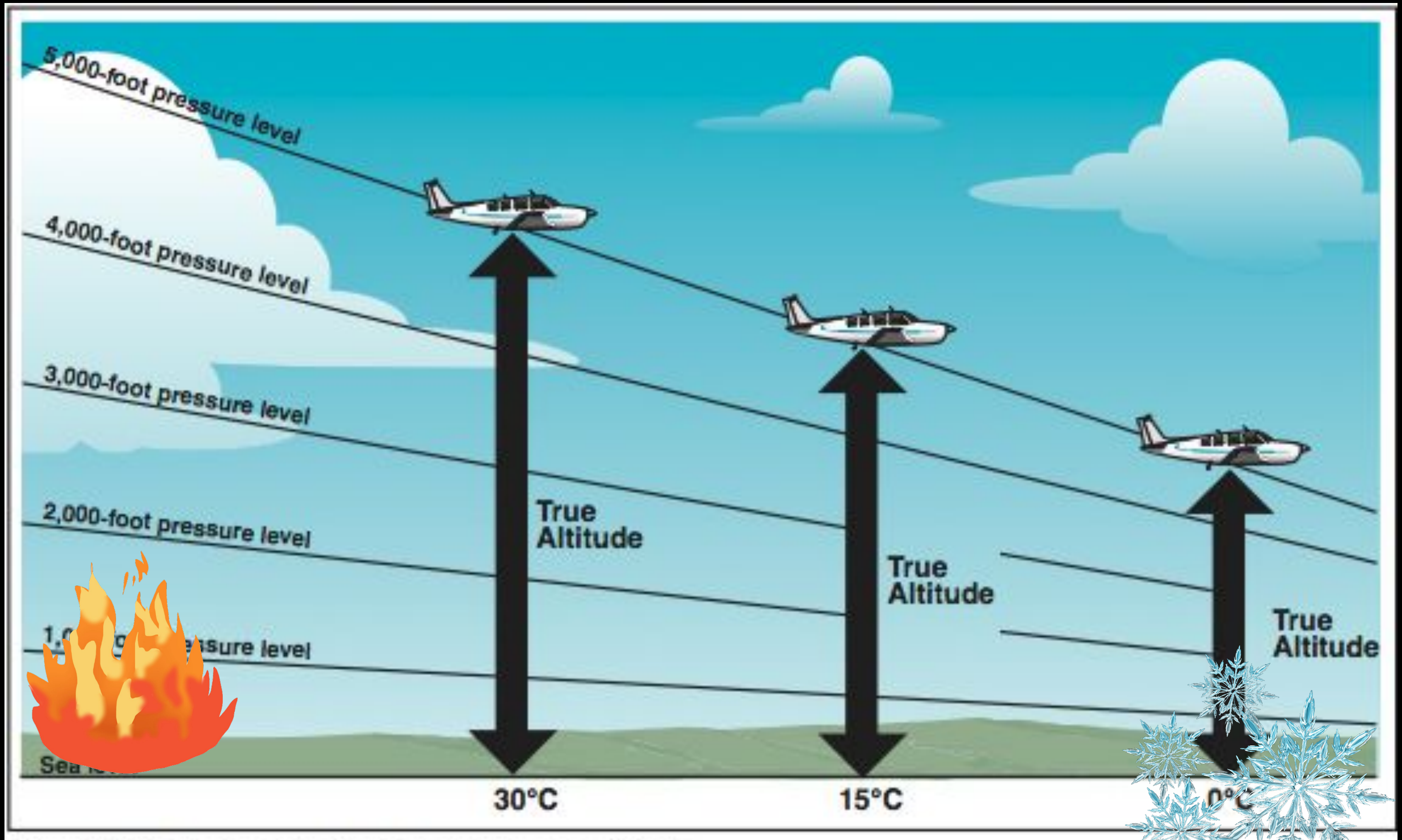
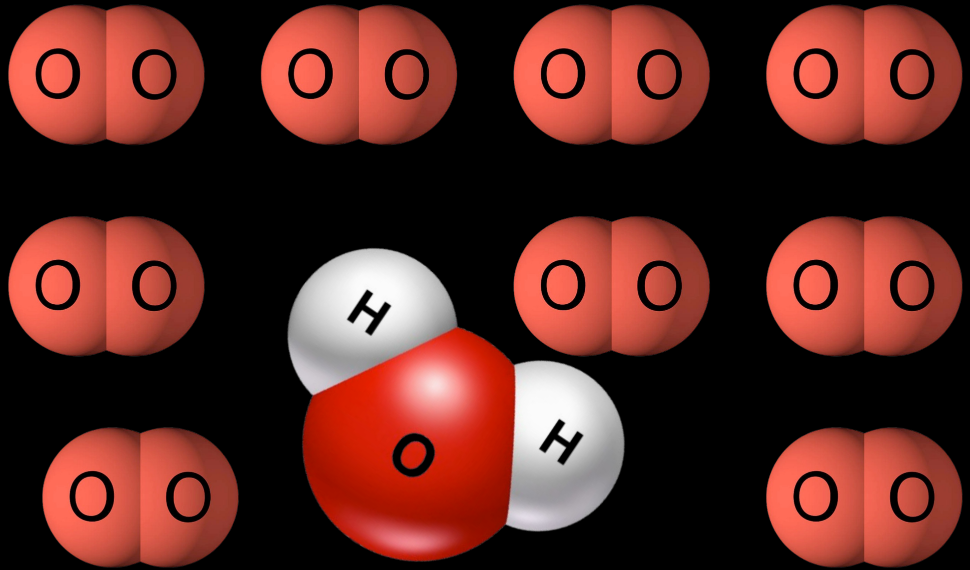


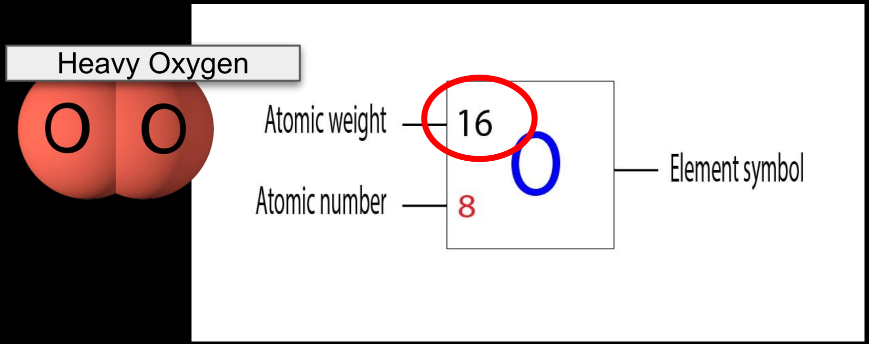
Figure 6-3. Effects of nonstandard temperature on an altimeter.

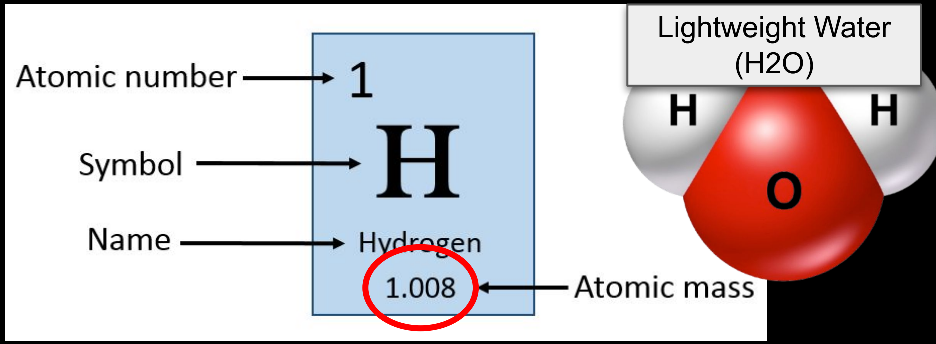
What changes air density?

1. Air Pressure
2. Temperature
3. **Humidity***

**Humidity is dependant upon temp. So, it is reasonably accurate to ignore in our everyday calculations.*







How *dense* is the air?

We use a formula to relate air density to the altitude the airplane would “feel” like it's at.

<u>Step 1: calculate Pressure altitude (height above standard 29.92)</u>

P.A. = Indicated Altitude + ([29.92 - alt. setting)x1,000)

<u>Step 2: calculate Density Altitude (account for temperature)</u>

D.A. = P.A. + (120x[OAT - standard temp])

(step 2 may be done with E6B)