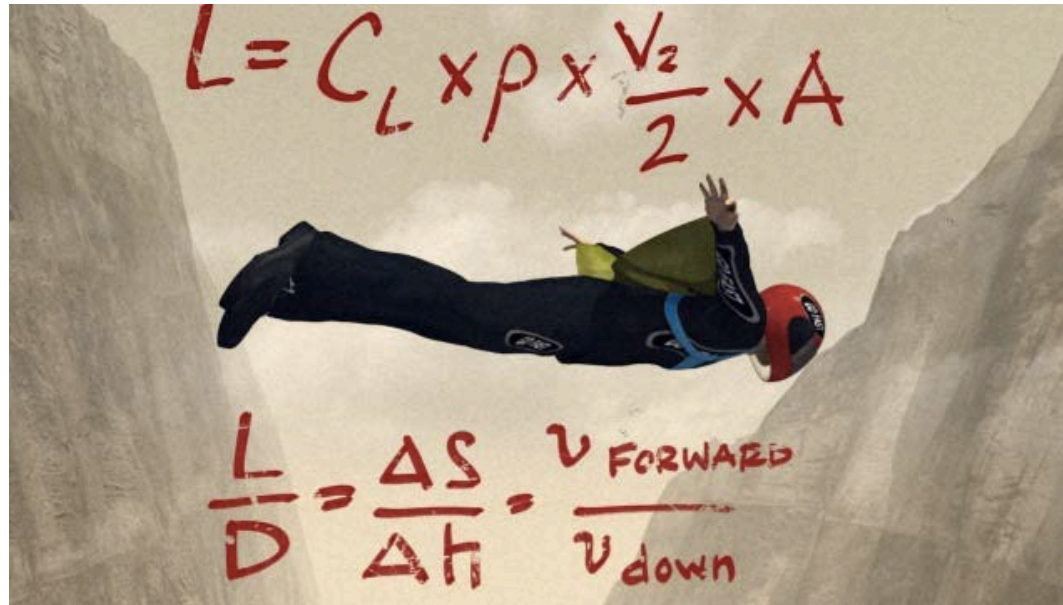


The Physics of Air



Oregon State UNIVERSITY **OSU** College of Science

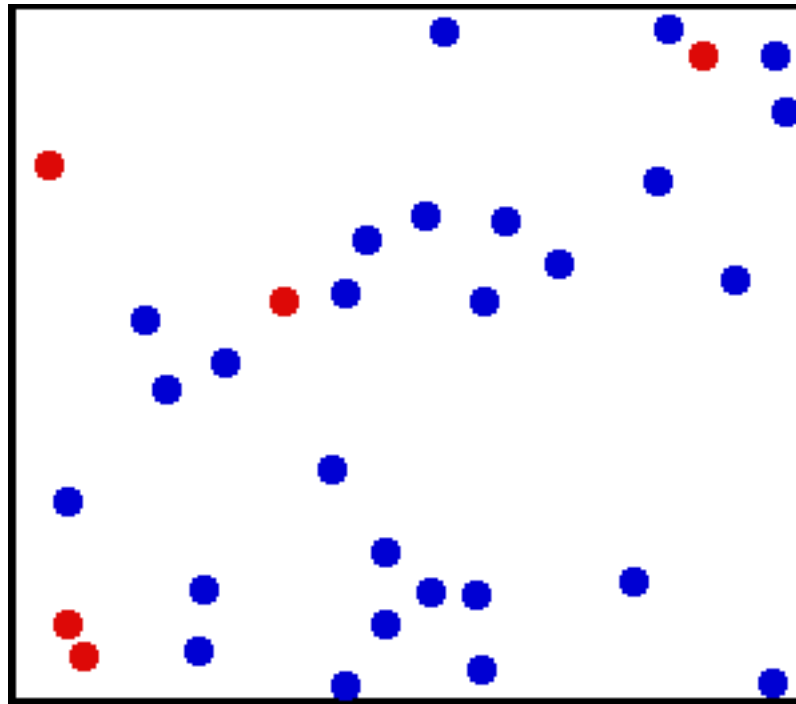
Weniger 151, January 11th 2015



Why do some bubble float, some bubbles sink?

Demo #1: Kids blow bubbles, someone makes bubbles from a He tank and a propane tank

Air is made of tiny tiny tiny particles...



Demo #2: Open the scales of the universe website and zoom from human scale to atomic scale

Demo #3: Colorful juggling balls (balloons stuffed with dry rice) are used to represent gas molecules of different mass, do some juggling!



When you blow on your hand, you are feeling millions and millions of these tiny atoms colliding with your hand

The starting point for explaining...



Things that float





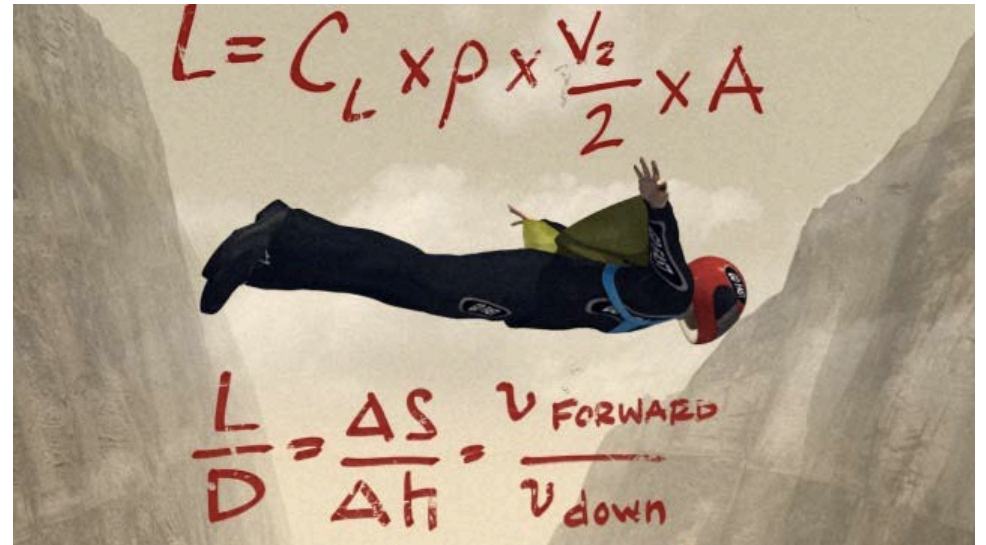
Things that fly



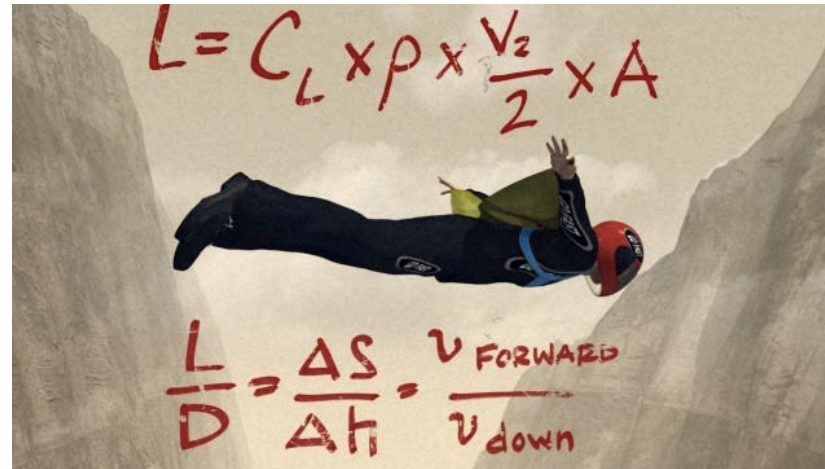
Wind energy



crazy adventure sports



The Physics of Air



phys·ics  *noun plural but singular or plural in construction* \ˈfɪ-zɪks\
construction \ˈfɪ-zɪks\
: a science that deals with matter and energy and the way they act on each other

Working definition for today:

Carefully observing things move (like atoms and planets...)
Asking how and why.

When I blow leaves, why do they move?



Demo #4: The “land yacht”. Use a cart that has minimal rolling friction. Give it a “sail”. Blow the cart across the room with a leaf blower. Now do the same thing by throwing the colorful juggling balls into the sail. Discuss the equivalence. In both cases we transfer momentum from high velocity particles (air molecules or juggling balls).



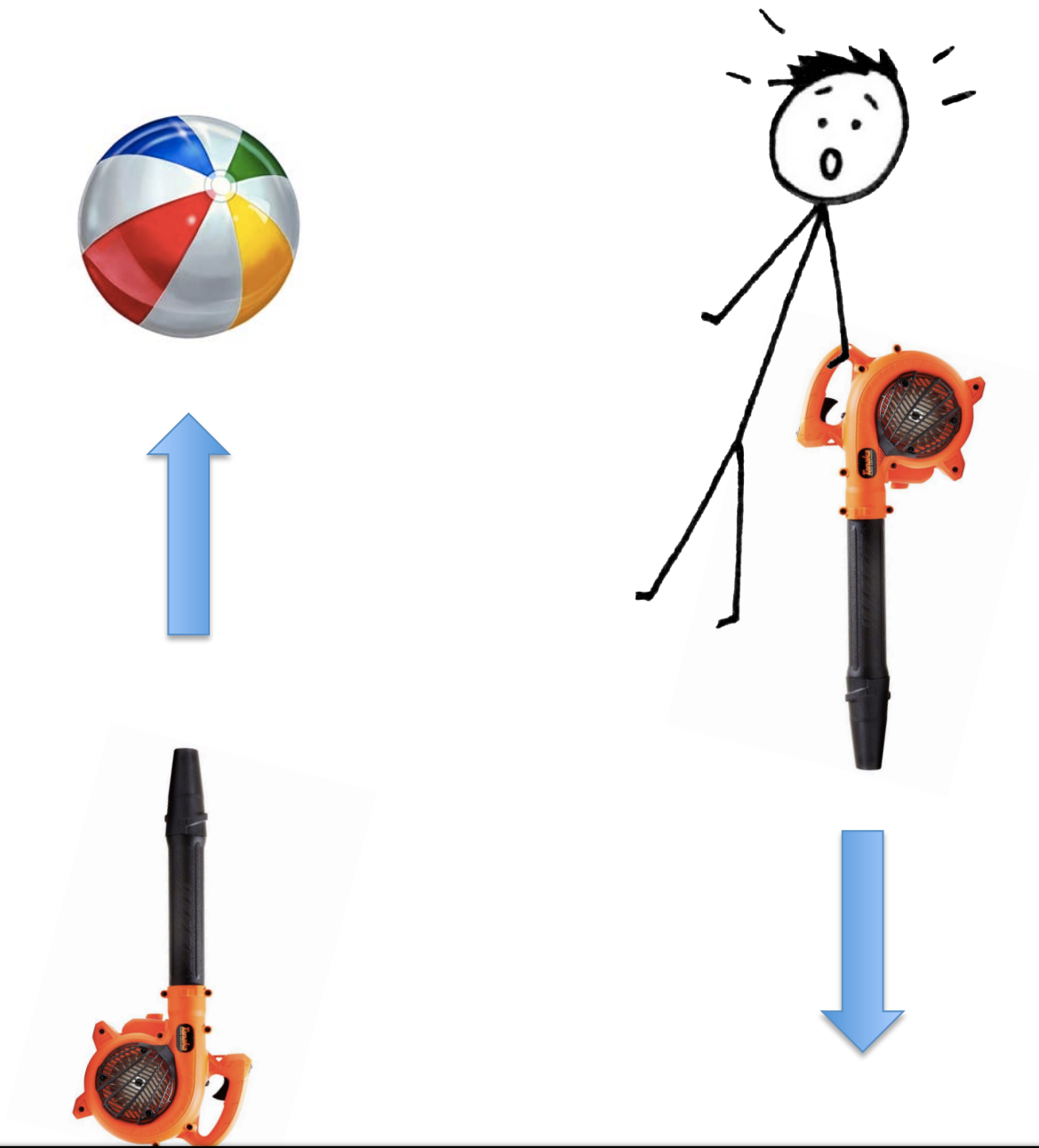
Demo #5: Make a beach ball float in the airstream of the leaf blower

How hard can I push something using air?

Time for a physics equation!

(experiment to validate the physics equation)

Demo #6: Measure the velocity of air coming out of the leaf blower. Do a back of the envelop calculation to estimate the force exerted by the air onto a sail. Discuss the units that I use to measure things like velocity and air density. Verify the calculation by attaching a sail to a Newton meter. The force will be a couple Newtons. Discuss the role of math. Discuss how physics predicts relationships between quantities that have different unit (e.g. relationship between air velocity and force).



Demo #7: Use a Newton meter to see how much force it would take to lift a 5-year-old kid (the kid can hang on the Newton meter). The leaf blow gives 2 N... is it enough?



Air goes down, helicopter is pushed up

Demo #8: The toy helicopter is much lighter than a kid. In this case, blowing air downward gives enough force. Pilot a toy helicopter around the room. Let people feel the down draft.



Flying into the air
from the recoil of air
molecules

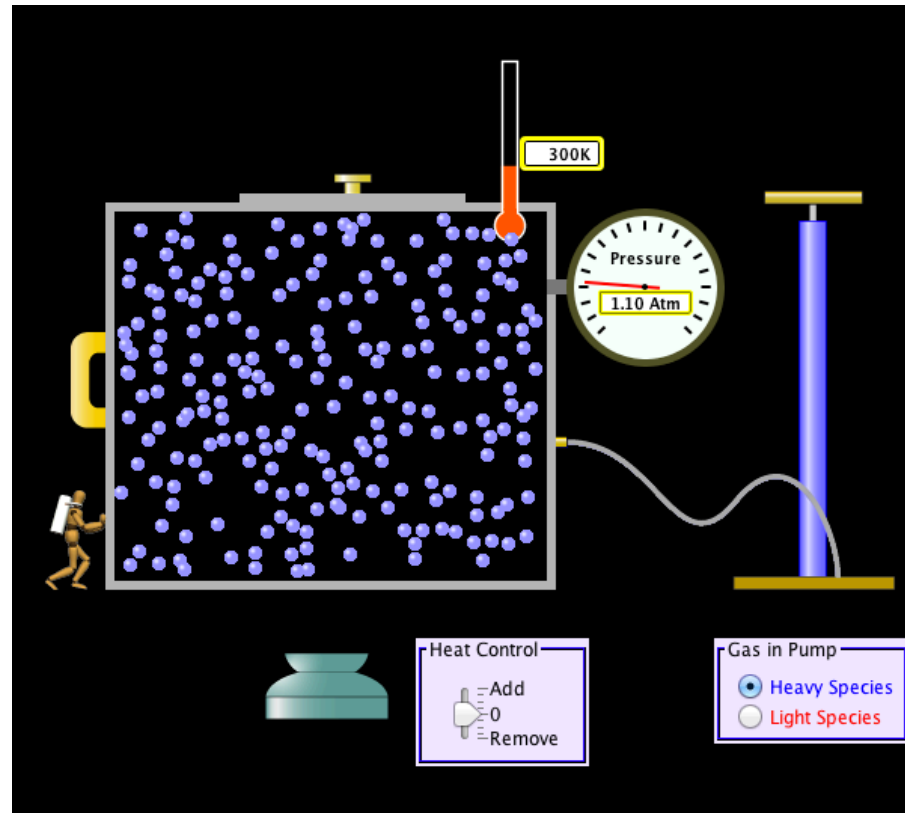


Floating on a bed of invisible air molecules



Demo #9: If we can't fly like a helicopter... what's the next best thing I can do with a leaf blower?
Give a kid a ride on a homemade hoverboard. Everyone else gets a turn at the end of the event.

Molecular kinetics gas simulation module



Demo #10: Explain how the hover board worked using this PHET simulation. A small excess of air molecules in the chamber increases the pressure.





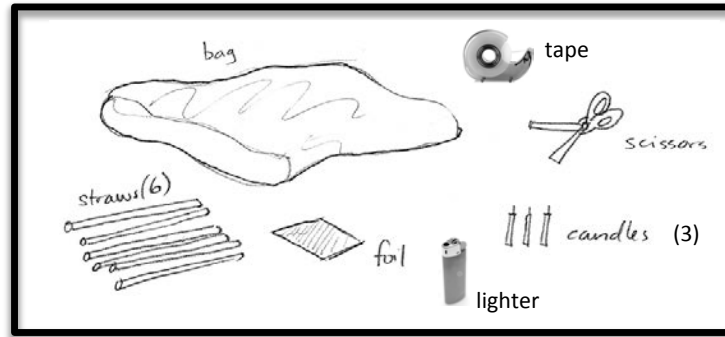
What about hot air balloons?



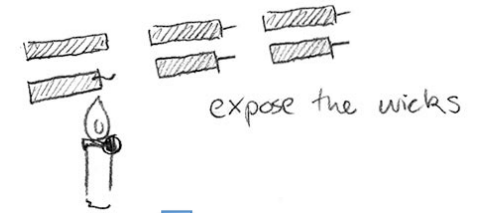
The best way to understand something is to build it...

Activity #1: Teams of two kids with one parent overseeing. Build hot air balloon.

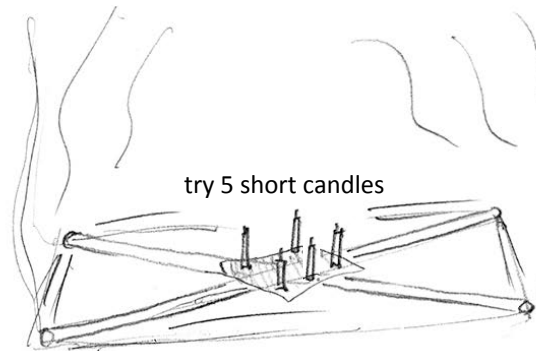
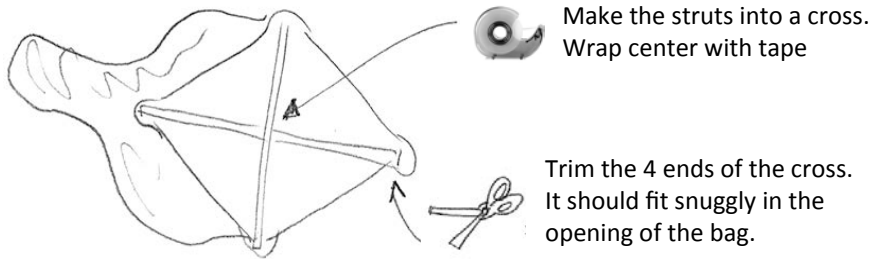
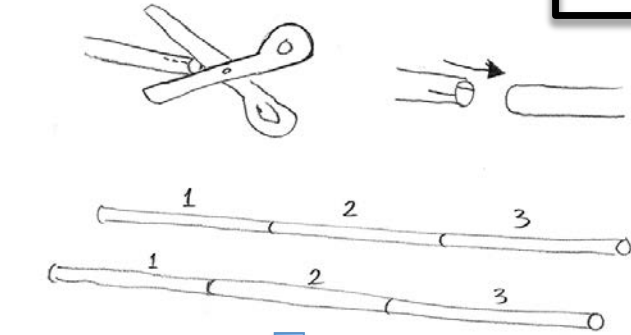
Drinking straws
& plastic bag



Birthday candles
& foil

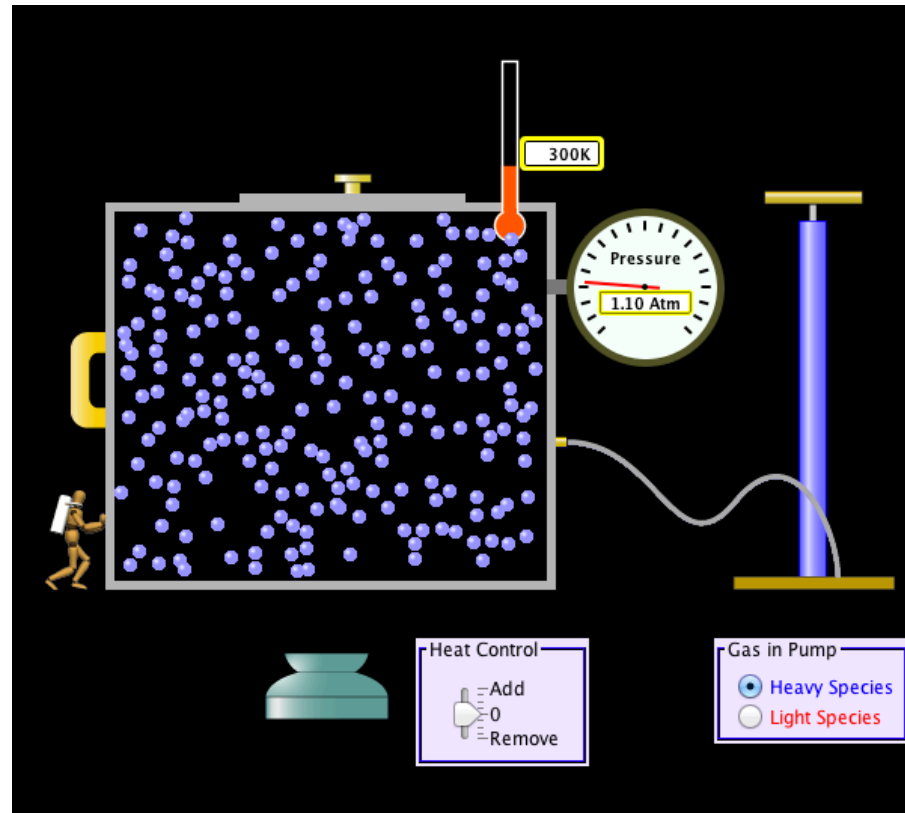


melt the bottom



With the cross in the bag,
tape the candle platform to
the cross.

Molecular kinetics gas simulation module



Demo #10: Explain how the hot air balloon worked using the same PHET simulation. A small input of heat makes the air molecules move faster, fewer air molecules in the chamber needed to maintain atmospheric pressure.

Every good theory makes a prediction...

If hot gas molecules fill more space...

cold gas molecules fill less space



Demo #11: Kids inflate balloons (balloons must be filled with humid air), then balloons are put into a cooler that has liquid nitrogen. Remember, safety first! Kids need clear instructions about keeping themselves safe from LN₂.

(typical freezer -18°C)

Beyond the physics of air

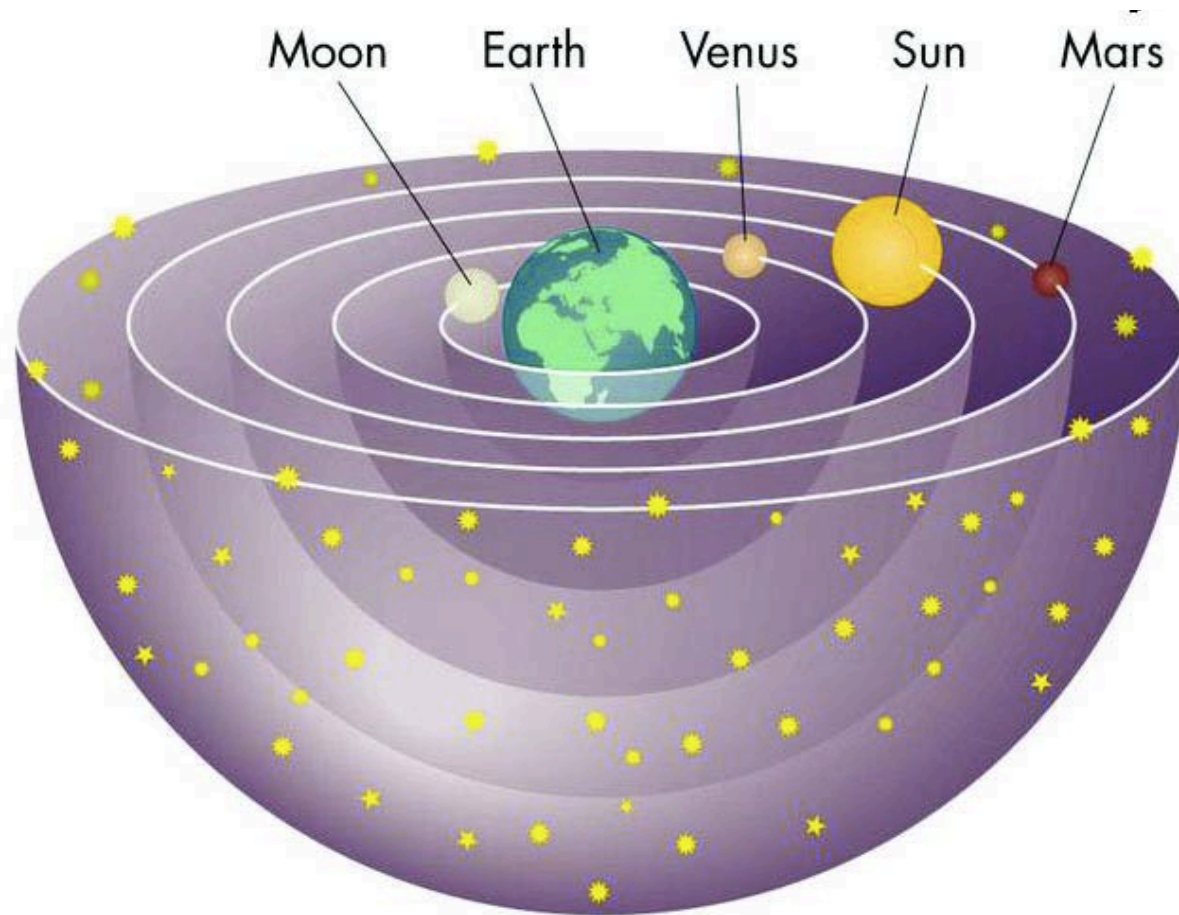
Physics (working definition for today):

Carefully observing how things move (things like atoms and planets...)

Asking how and why.

(Short lecture about how Physics informs philosophy)

Example 1: Earth-at-the-center-of-everything theory



(by carefully observing the trajectories of the planets, seeing that Venus and Mars travelled in “loop-the-loop” paths relative to earth, physicists understood that a more elegant explanation was that the earth was also making circular orbits)

Earth-like-a-speck-of-dust theory

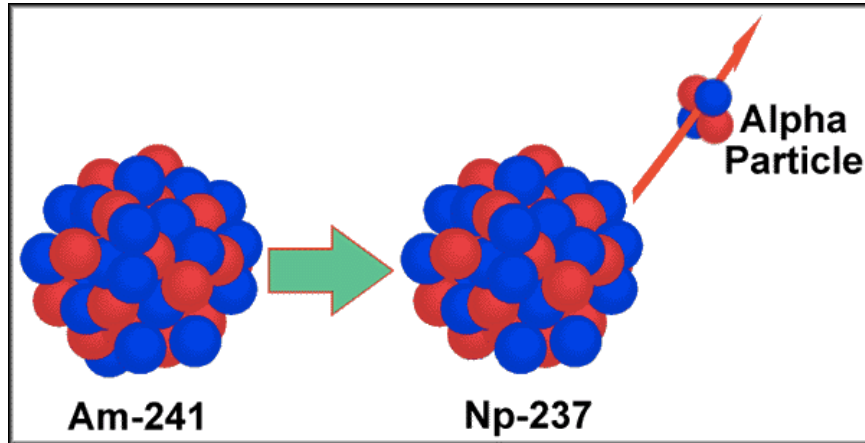
A star like our Sun

“Far out in the uncharted backwaters of the unfashionable end of the western spiral arm of the Galaxy lies a small unregarded yellow sun. Orbiting this at a distance of roughly ninety-two million miles is an utterly insignificant little blue green planet...”

Douglas Adams

(The Hitchhiker's Guide to the Galaxy)

Example 2: The microscopic world (quantum mechanics)



Observation of atoms



Quantum mechanics is probabilistic

Everything is a game of chance

Careful observation



Change the way people think about things

Final Exam

Consider gas molecules that are 2x heavier than surrounding air
and 3x hotter than surrounding air...



Demo #12: The spectacular explosion at the end of the show. Involves 6" diameter soap bubbles filled with propane. Remember safety first! Kids need clear instructions where to stand.

Thanks for coming!

Line up in foyer for 1st-round of hover board rides

Come sit in the front rows if you'd like to ask questions (and get 2nd-round hover board rides)