States of Matter

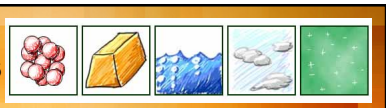
Chp 3: Lecture 1

Let's start with Tim & Moby

- States of matter

- Brainpop Answers
- 1. B
- 2. C
- 3. D
- 4. A
- 5. B
- 6. C
- 7. D
- 8. B
- 9. B
- 10 C

5 States



- All matter exists in some sort of physical form or **a state of matter**.
- There are 5 states of matter:
  1. **Solid**
  2. **Liquid**
  3. **Gas**
  4. **Plasma**
  5. Bose-Einstein Condensate (**BEC**)

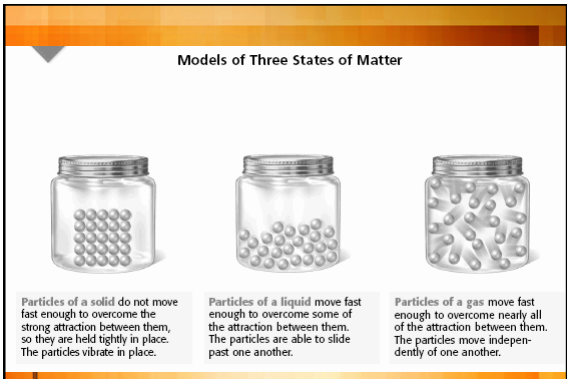
The particles are movin'

- Matter is made up of little atoms
- These atoms are constantly moving and bumping into one another.
- The state of matter of a substance depends on 2 things:
  1. how **fast** the particles are **moving**
  2. how **strongly** the particles are **attracted** to one another

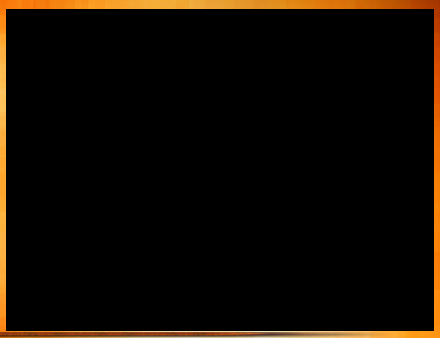
2. Bill Nye: Phases of Matter

The atoms move very differently

- **Solids** are solid. The atoms are locked in place and vibrate microscopically.
- **Liquids** move a little bit more. These atoms can slide past one another, but are still connected.
- **Gases** are unconnected and shoot all over the place.



3. Matter Animation



Solids

- The atoms in a solid are tightly packed together.
- That's why they feel hard - the closer your molecules are, the harder you are.
- Solids also can hold their own shape.
- A rock will always look like a rock unless something happens to it.
- Solids like their shape and don't want to change.
- **Summary:**
  Solids have a **definite volume** and hold **shape.**

Two types of Solids

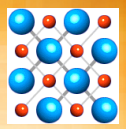
There are 2 types of solids:

1. **Crystalline** solids
2. **Amorphous** solids

Crystalline Solids

- A crystalline solid has a **very orderly** and 3D arrangement of molecules.
- Think seats in a movie theater – they are all lined up, in rows and columns.

Examples of Crystalline Solids



- Salt
- Diamonds
- Ice
- A crystal is a solid that was ***slowly*** formed

Amorphous Solids

- Amorphous solids are made of atoms that are in **no particular** order.
- Think of going to the beach - you sit wherever there's room.
- Same thing when you go see a concert in a park.
- Each person has *a spot*, but there is *no order* or **no pattern.**

Examples of Amorphous Solids

- Amorphous solids do not have a definite melting point and can exist in two different states:
  - a "rubbery" state
  - a "glassy" state.
- Examples:
  - Butter
  - Rubber
  - Glass
  - wax

Weird Solids

- Some substances act like a solid and a liquid.
- Jello, Peanut Butter, Whole Milk, SLIME!
- You can spread peanut butter on bread, but peanut butter does not flow, right?
- It is not a liquid at room temperature.
- When you make Jello, it is first a liquid.
- You have to put it in the refrigerator so that it becomes a solid.
- These yummy forms of matter with properties of a liquid and a solid are called **colloids**.

Flowing Fluids

- A **fluid** is a form of matter that flows when any force is applied, no matter how small.
- **Liquids** are one kind of fluid, **gases** are another.
- You have seen water flow from a faucet (or overflow a sink) and felt cool air flow through an open window (or carry the aroma of cooking food into your room).
- Let's talk about liquids first.

Lovely Liquids

- A liquid is a substance that has **volume** and **mass**, but **no definite** shape.
- It takes the **shape** of its container.
- Think of what would happen if you knocked this glass of Coke over - It would spread all over the table, onto the floor, all over until it was spread out as far as it could possibly go!
- But when you pour it into a cup, it fills it up as much as possible.

How do liquid molecules move?

- The molecules in liquid water have more **energy** and move around much more than do the molecules in ice.
- In a liquid, molecules can slide over and around each other.
- This is how liquids flow and change shape.
- But the atoms do not have enough energy to completely break their bonds with one another.
- That is why liquids have **constant** volume even though the shape may change.
- Think of the balls in a ball pit - they spread out as much as they can, to fill the shape of the pit.

Liquids have a definite volume

- In fact, liquids don't like to change their volume, even if they don't mind changing their shape.
- Example: it doesn't matter whether you pour a soda into a big glass or small glass, you'll still have the same amount and it'll take up the same amount of space (volume).
- But think of how hard it would be to force a liquid, or **compress** it, into a small space.

Two Properties of Liquids

- **Viscosity** --The *resistance* of a liquid to flow. Think of pouring honey (high viscosity) vs. water (low viscosity).

- **Surface Tension** -- The molecules on the surface of a liquid are sometimes so strongly attracted to one another that they form a sheet across the top. This is what lets bugs like water skaters stay atop water.

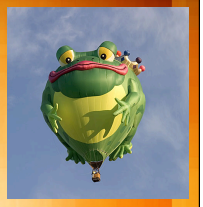
Giddy Gases

- Gas is everywhere.
- Our atmosphere is a big layer of gas that surrounds the Earth.
- Gases are **random** groups of atoms.
- In solids, atoms and molecules are compact and close together.
- Liquids have atoms a little more spread out.
- However, gases are really spread out and the atoms and molecules are full of energy.
- They are bouncing around constantly - that's why they're giddy!

How do gas molecules move?

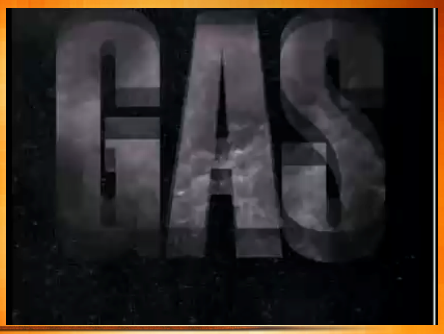
- Remember, gas atoms and molecules move very quickly.
- They move so quickly, that they can completely break away from one another.
- When they break away, they collide and bump into one another constantly.
- This causes them to spread out as much as they can.

Gases Do NOT have a definite volume



- Gases can fill a container of any size or shape.
- Think about a balloon - No matter what shape you make the balloon it will be evenly filled with the gas atoms.
- The atoms and molecules are spread equally throughout the entire balloon.
- Liquids can only fill the bottom of the container while gases can fill it entirely.

4. Bill Nye: Part 2



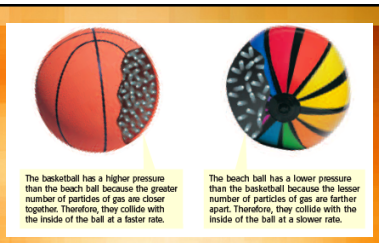
Awful Science Humor

Did you hear about the chemist who was reading a book about helium?

He just couldn't put it down.

Let's Talk Pressure

- A force applied to a fluid creates **pressure**.
- Pressure acts in **all directions**, not just the direction of the applied force.
- When you inflate a basketball, you are increasing the pressure in the ball.
- A pressure of 30 pounds per square inch means every square inch of the inside of the ball feels a force of 30 pounds.
- This force acts up, down, and sideways in all directions inside the ball.
- This is also what makes the basketball feel solid, even though it is filled with air.



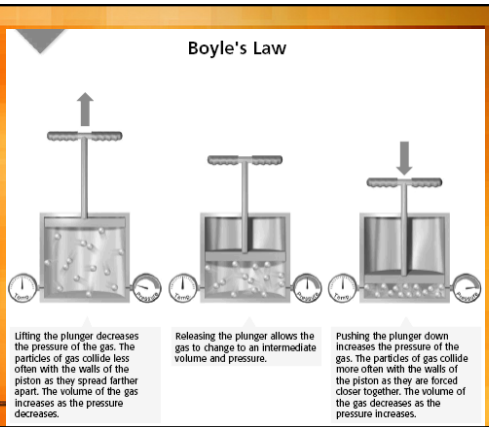
The basketball has a higher pressure than the beach ball because the greater number of particles of gas are closer together. Therefore, they collide with the inside of the ball at a faster rate.

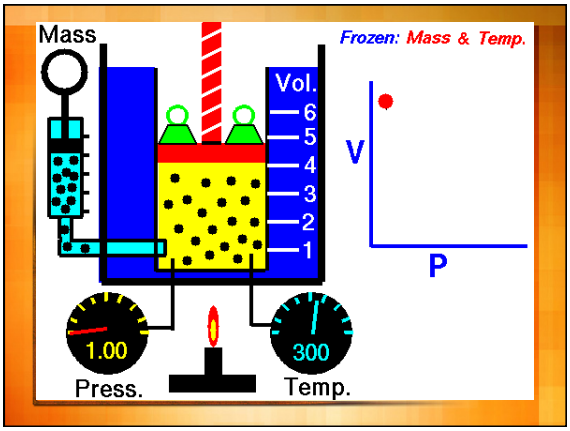
The beach ball has a lower pressure than the basketball because the lesser number of particles of gas are farther apart. Therefore, they collide with the inside of the ball at a slower rate.

- Compare the basketball to the beach ball though.
- Even though they have the same volume, the basketball has much more air particles compressed into it.
- This causes a higher pressure, which causes the basketball to feel more solid.

Boyle's Law

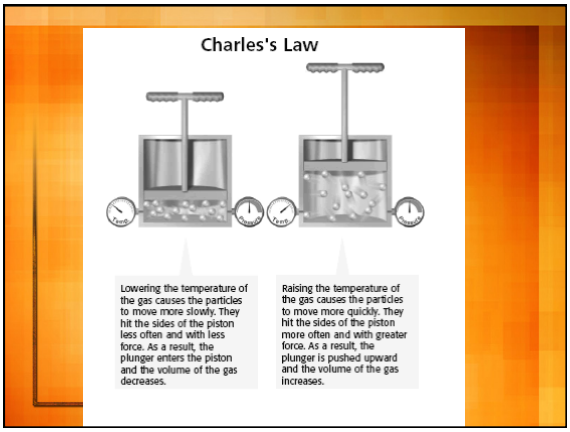
- Robert Boyle wrote a law that states:
  - For a fixed amount of gas at a constant temperature, the volume of the gas increases as its pressure decreases.
- **P x V = constant**
- ↑Pressure then ↓Volume
- ↓Pressure then ↑ Volume

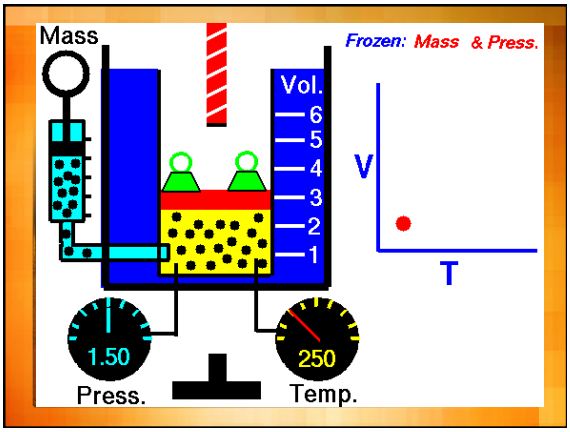




Charles's Law

- Jacques Charles wrote a law that states:
  - For a fixed amount of gas at a constant pressure, the volume of the gas increase as its temperature increases.
- **V/T = constant**
- ↑Volume then ↑ Temperature
- ↓Volume then ↓Temperature





Pulsating Plasmas

- The 4th state of matter, plasma is matter that does not have a definite **shape** or **volume** and whose particles have broken apart.
- Plasma is an **ionized gas**, a gas into which sufficient energy is provided to free electrons from atoms or molecules and to allow both species, ions and electrons, to coexist.
- In other words, a plasma is a **gas** that has **electricity** running through it.

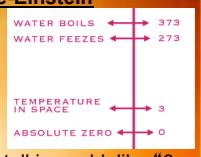
Little Book Graph Drawing

- Turn to page 4 in your little book and complete the drawing of the graphs for both Boyle & Charles' Laws

- Plasmas are the **most common** state of matter in the universe.
- Plasma occurs naturally and makes up the stuff of our sun, the core of stars and occurs in quasars, x-ray beam emitting pulsars, and supernovas.
- On Earth, plasma is naturally occurring in **flames, lightning,** and the **auroras** (northern & southern lights).
- Artificial plasmas include fluorescent lights.

A fifth state of matter?

- A fifth state of matter called **Bose-Einstein Condensation** was proved in 1995 by two men at the University of Colorado.
- This phenomenon was originally predicted in the 1920s by Satyendra Nath Bose and Albert Einstein.



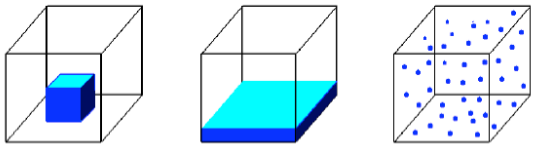
- At ultra-low temperatures, we're talking cold, like "3 degrees above Absolute Zero, the coldest you can possible get", atoms begin to stop moving.
- Einstein wondered, what would happen if this occurred in a gas?
- Remember, a gas is defined by the fact that its particles move!

A Fifth State of Matter

- The **Bose-Einstein (BEC)**state of matter was the only one created while your parents were alive. In 1995, two scientists, Cornell and Weiman, finally created the condensate.
- When you hear the word **condensate**, think about condensation and the way gas molecules come together and condense and to a liquid.
- The molecules get **denser** or packed closer together.
- Two other scientists, Satyendra Bose and **Albert Einstein**, had predicted it in the 1920s, but they didn't have the equipment and facilities to make it happen at that time.
- Now we do. If plasmas are super hot and super excited atoms, the atoms in a Bose-Einstein condensate (BEC) are total opposites.
- They are super unexcited and super cold atoms.

Review –

Draw the Boxes & write the info



Solid	Liquid	Gas
Holds Shape	Shape of Container Free Surface	Shape of Container
Fixed Volume	Fixed Volume	Volume of Container

States of Matter Summary

Matter-piece Theater

- This is a ton of information to remember, yes?
- In my opinion, one of the best ways to remember information is by getting a little silly and pretending to "BE" the information.
- Time for a little acting.
- Each person in your group is going to act out a state of matter:
  - Letter A: Solid
  - Letter B: Liquid
  - Letter C: Gas
  - Letter D: Plasma
- Take 1 minute to decide how you are going to act.
- On the count of 3, stand up and show your group.