States of matter

Youtubehttps://www.youtube.com/watch?v=wclY8F-UoTE

http://www.chem4kids.com/files/matter_states.html

States of Matter

We look at five **states of matter** on the site. Solids, liquids, gases, plasmas, and Bose-Einstein condensates (BEC) are different states that have different physical properties. Each of these states is also known as a **phase**. Elements and compounds can move from one phase to another when specific physical conditions change. For example, when the temperature of a system goes up, the matter in the system becomes more excited and active. If enough **energy** is placed in a system, a phase change may occur as the matter moves to a more **active state**.

Think about it this way. Let’s say you have a glass of water (H_2O). When the temperature of the water goes up, the molecules get more excited and bounce around a lot more. If you give a liquid water molecule enough energy, it escapes the liquid phase and becomes a gas.

Have you ever noticed that you can smell a turkey dinner after it starts to heat up? As the energy of the molecules inside the turkey heat up, they escape as a gas. You are able to smell those **volatile - נדיף** molecules that are mixed in the air.

It’s About the Physical

"Phase" describes a physical state of matter. The key word to notice is **physical**. Things only move from one phase to another by physical means. If energy is added (like increasing the temperature) or if energy is taken away (like freezing something), you have created a physical change.

When molecules move from one phase to another they are still the same substance. There is water **vapor** above a pot of boiling water. That vapor (or gas) can **condense** and become a drop of water in the cooler air. If you put that liquid drop in the freezer, it would become a solid piece of ice. No matter what physical state it was in, it was always water. It always had the **same chemical properties**.

On the other hand, a chemical change would build or break the chemical **bonds** in the water molecules. If you added a carbon (C) atom, you would have formaldehyde (H_2CO). If you added an oxygen (O) atom, you would create hydrogen peroxide (H_2O_2). Neither new compound is anything like the original water molecule. Generally, changes in the physical state do not lead to any chemical change in molecules.

States of Matter Examples

A Liquid Ocean

There are many liquids around you. Oceans, rivers, lakes, and rivers are good examples of liquid water (H_2O). Planetary scientists are looking for other planets that have liquid water, but planets require very specific conditions to have water as we know it.

Solids in Ceramics

Ceramic bowls are a great example of a solid. Did you know that many of the items found from ancient civilizations are pieces of pottery? Ceramic materials are usually made from soft clay that is heated up and then slowly cooled. The clay becomes very hard because **water** (H_2O) is removed and the chemical bonds inside the clay change.

Plasmas on the Sun

Plasmas are highly energized gases that have lost their electrons. Stars, including the Sun, are covered in plasma. Hydrogen (H) and helium (He) ions float around the Sun with their electrons moving freely.

Gases in Balloons

Balloons aren’t technically gases. They are little pieces of rubber. However, the helium (He) inside the balloon is a gas. Helium is noble gas that has a very low atomic mass. In its gaseous state, it is lighter than air. That lightness is why balloons float.

Changing States of Matter

All matter can move from one **state** to another. It may require extreme temperatures or extreme pressures, but it can be done. Sometimes a substance doesn't want to change states. You have to use all of your tricks when that happens. To create a solid, you might have to decrease the **temperature** by a huge amount and then add **pressure**. For example, oxygen (O_2) will solidify at -361.8 degrees Fahrenheit (-218.8 degrees Celsius) at standard pressure. However, it will freeze at warmer temperatures when the pressure is increased.

Some of you know about liquid nitrogen (N_2). It is nitrogen from the atmosphere in a liquid form and it has to be super cold to stay a liquid. What if you wanted to turn it into a solid but couldn't make it cold enough to solidify? You could increase the pressure in a sealed chamber. Eventually you would reach a point where the liquid became a solid. If you have liquid water (H_2O) at room temperature and you wanted water vapor (gas), you could use a combination of high temperatures or low pressures to solve your problem.

Points of Change

Phase changes happen when you reach certain special points. Sometimes a liquid wants to become a solid. Scientists use something called a **freezing point** or **melting point** to measure the temperature at which a liquid turns into a solid. There are **physical** effects that can change the melting point. **Pressure** is one of those effects. When the pressure surrounding a substance increases, the freezing point and other special points also go up. It is easier to keep things solid when they are under greater pressure.

Generally, solids are more **dense** than liquids because their molecules are closer together. The freezing process compacts the molecules into a smaller space.

There are always exceptions in science. Water is special on many levels. It has more space between its molecules when it is frozen. The molecules organize in a specific arrangement that takes up more space than when they are all loosey-goosey in the liquid state. Because the same number of molecules take up more space, solid water is less dense than liquid water. There are many other types of molecular organizations in solid water than we can talk about here.

Online quiz

http://www.chem4kids.com/extras/quiz_matterstates/index.html

CHEMISTRY TERM	PHASE CHANGE
Fusion/Melting	Solid to a Liquid
Freezing	Liquid to a Solid
Vaporization/Boiling	Liquid to a Gas
Condensation	Gas to a Liquid
Sublimation	Solid to a Gas
Deposition	Gas to a Solid

Gas to a Plasma and Back to a Gas

Let's finish up by imagining you're a gas like neon (Ne). You say, "Hmmmm. I'd like to become a plasma. They are too cool!" As a gas, you're already halfway there, but you still need to tear off a bunch of electrons from your atoms. The gas needs to ionize. Electrons have a **negative charge**. Eventually, you'll have groups of positively and negatively charged particles in almost equal concentrations. They wind up in a big plasma ball. Because the positive and negative charges are in equal amounts, the charge of the entire plasma is close to **neutral**. Neutral happens when a whole bunch of positive particles cancel out the charges of an equal bunch of negatively charged particles.

Plasma can be made from a gas if a lot of energy is pushed into the gas. In the case of neon, it is **electrical energy** that pulls the electrons off. When it is time to become a gas again, just flip the neon light switch off. Without the **electricity** to energize the atoms, the neon plasma returns to its gaseous state. We have a special world here on Earth. We have an environment where you don't find a lot of everyday plasma. Once you leave Earth and travel through the Universe, you will find plasma everywhere. It's in the stars and all of the space in between.

http://easyscienceforkids.com/all-about-states-of-matter/

http://www.chem4kids.com/files/matter_changes.htm\

Liquid to a Gas and Back to a Liquid

When you are a liquid and want to become a gas, you need to find a lot of **energy**. Once you can direct that energy into your molecules, they will start to **vibrate**. If they vibrate enough, they can escape the limitations of the liquid environment and become a gas. When you reach your **boiling point**, the molecules in your system have enough energy to become a gas.

The reverse is true if you are a gas. You need to lose some energy from your very excited gas atoms. The easy answer is to lower the surrounding temperature. When the temperature drops, energy will be **transferred** out of your gas atoms into the colder environment. When you reach the temperature of the **condensation point**, you become a liquid. If you were water vapor over a boiling pot of water and you hit a wall, the wall would be cool, absorb some of your extra energy, and you could quickly become a liquid. Cooler objects often absorb energy from hotter objects.

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More on Phase Changes from Part I...

Gases Under Pressure

If you have a propane (C_3H_8) barbecue, you have probably seen those cylinders filled with fuel. In the cylinder, the propane molecules are in a liquid state at a high pressure. When the molecules are released from the cylinder, they immediately become a gas and you can cook your food. Pressure differences make the phase change.

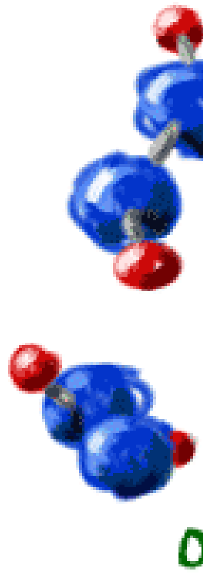
Melting Ice

You can watch phase changes at home when you put a piece of ice (solid) on a counter. As long as the temperature is above 0 degrees Celsius, that ice cube will warm and melt. That melted puddle of water (H_2O) is a liquid. Heat makes the phase change. Have a towel ready to clean up the mess.

Plasma in Tubes

In many signs, there are glass tubes filled with neon (Ne) gas. Normally, the gas stays a gas. When you turn on the sign and send an electric **current** through the tubes, the neon loses its electrons and becomes plasma. Electricity makes the phase change.

Chemical Changes Versus Physical Changes



It is important to understand the difference between **chemical** and **physical** changes. Some changes are obvious, but there are some basic ideas you should know. Physical changes are usually about physical states of matter. Chemical changes happen on a **molecular** level when you have two or more molecules that interact. Chemical changes happen when atomic bonds are broken or created during chemical reactions.

No Change to Molecules

When you step on a can and crush it, you have forced a physical change. However, you only changed the shape of the can. It wasn't a change in the state of matter because the energy in the can did not change. Also, since this was a physical change, the molecules in the can are still the same molecules. No chemical bonds were created or broken.

When you melt an ice cube (H_2O), you have a physical change because you add **energy**. You added enough energy to create a phase change from solid to liquid. Physical actions, such as changing temperature or pressure, can cause physical changes. No chemical changes took place when you melted the ice. The water molecules are still water molecules.

Changing the Molecules

Chemical changes happen on a much smaller scale. While some experiments show obvious chemical changes, such as a color change, most chemical changes are not visible. The chemical change as hydrogen peroxide (H_2O_2) becomes water cannot be seen since both liquids are clear. However, behind the scenes, billions of chemical bonds are being created and destroyed. In this example, you may see bubbles of oxygen (O_2) gas. Those bubbles are evidence of the chemical changes.

Melting a sugar cube is a physical change because the substance is still sugar. Burning a sugar cube is a chemical change. Fire activates a chemical reaction between sugar and oxygen. The oxygen in the air reacts with the sugar and the chemical bonds are broken.

Iron (Fe) **rusts** when it is exposed to oxygen gas in the air. You can watch the process happen over a long period of time. The molecules change their structure as the iron is **oxidized**, eventually becoming iron oxide (Fe_2O_3). Rusty pipes in abandoned buildings are real world examples of the oxidation process.

Online quiz

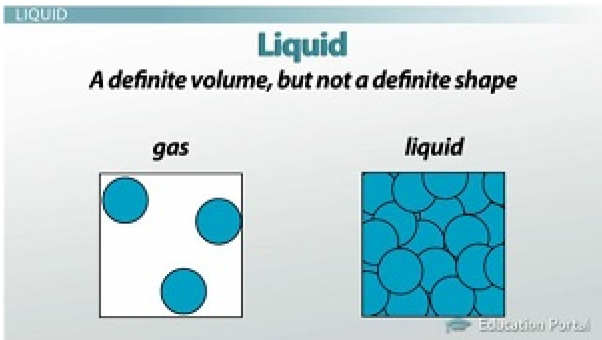
http://www.chem4kids.com/extras/quiz_matterstates/index.html

http://study.com/academy/lesson/states-of-matter-solids-liquids-gases-plasma.html

Gas

All matter exists in one of four states - gas, liquid, solid and plasma.

Open a bottle of perfume in one corner of a room, then move to the opposite corner and wait. In only a few minutes, you will be able to smell that perfume. Why is that? Because air is a gas and the perfume molecules evaporate into a gas and disperse into the gaseous air. Gases consist of tiny particles or molecules that are really far apart relative to their size. These molecules have so much room to move around that pretty soon the two gases have mixed, and the perfume has spread throughout the room.



Liquid molecules are more tightly compacted than gas molecules.

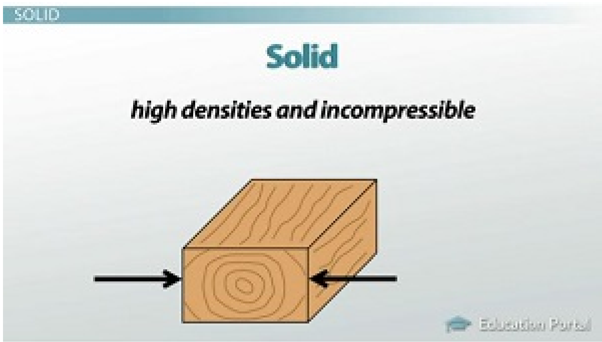
Gas is a form of matter that does not have a definite volume or shape. Gases have low density compared to the same substance in other states. Gases are also able to diffuse easily, as shown in the perfume example.

Liquid

Now look at a bottle of water. What properties do you know about that liquid? You can tell that the liquid takes the shape of the bottle, and you probably know that if you pour the liquid water into a different container, it will take the shape of the new container. You also probably know that no matter how hard you push on the water, you can never change its volume. Whether it is in a tall, narrow bottle or spread out over a table top, **liquid** has a definite volume, but not a definite shape. Contrast this with gas, which has no definite fixed shape or volume.

In a liquid, the molecules are more tightly packed but can still move and flow past each other. Liquids are able to diffuse and mix with other liquids, but it is a slower mixing than in gases. Another property common to all liquids is surface tension. Surface tension is a force of attraction that keeps molecules on the surface of a liquid together, causing tension. This is why bugs can walk on water.

Solid



Higher density solids have a definite shape and volume.

Now look at a block of wood. Try to push on it. Have an elephant stand on it. What can you say about it? You can say that this solid block of wood has a definite volume and a definite shape. It doesn't change shape even with the elephant standing on it - unless of course he disintegrates it, but let's pretend this is a baby elephant. These are characteristics of a **solid** - it has a definite volume and shape. A solid has molecules too, they are just so tightly packed that they have limited movement and are incompressible and hold their volume and