Difference between evaporation and boiling

Evaporation occurs on the surface of liquid and it is a vaporization of liquid. It is a state of transition from liquid to gaseous state. The process occurs slowly and cannot be seen as well. It occurs when there is exposure of water to air and water molecules change into vapor and these vapors rise up and form clouds.

Boiling occurs on the entire mass of liquid and it is the vaporization of liquid. It occurs rapidly. It happens when the vapor pressure of the liquid is equal to the pressure exerted by the environmental pressure on liquid. It is a state of phase transition. The boiling occurs in three different stages: nucleate boiling, transition boiling and film boiling. There are no such stages for evaporation.

Boiling occurs when the temperature of the liquid is greater than the boiling point of the substance. Evaporation can occur at any temperature. It occurs as long as the substanceÂ  remainsÂ  liquid at a particular [temperature](http://www.differencebetween.net/science/difference-between-heat-and-temperature/).

According to Greg Bradburn, evaporation occurs when there is an increased energy present and occurs rapidly. It occurs from the bottom of the container when allowed to boil. The bubbles form at the bottom of the container and then rise on top of the container. In boiling, bubbles do not form at the bottom and rise to the surface. Evaporation occurs at room temperature and therefore, occurs at a slower rate when compared to boiling.

In boiling, there is formation of bubbles as it is a complex physical process and these bubbles are formed on a heated liquid. There is cavitation and acoustic effects seen in boiling. There is no such bubbles formed in evaporation and there is no cavitation and acoustic effect present in evaporation.

The microscopic difference between evaporation and boiling is as follows:

In boiling, the motion of particles is increased and this force separates the particles apart from each other. The temperature is uniform and the boiling also occurs throughout. In evaporation the movement of the particles is not the same. Few particles move at slower speed and few particles move at an increased speed. The surface particles are held in place by the particles beneath the surface layer and the particles in the middle layer is held by the forces acting on the sides of the container. The particles on the surface can break easily from the liquid.

SUMMARY:

1. Evaporation occurs on the surface of the liquid whereas boiling occurs at the entire length of liquid.  
2. Boiling occurs rapidly whereas evaporation occurs slowly.  
3. Evaporation occurs at any temperature whereas boiling occurs at a specific temperature.  
4. The motion of particles is fast in boiling whereas in evaporation few particles move slowly and few at a faster rate.  
5. There is formation of bubbles in boiling, but bubbles are not seen in evaporation.

Read more: [Difference Between Evaporation and Boiling | Difference Between | Evaporation vs Boiling](http://www.differencebetween.net/science/difference-between-evaporation-and-boiling/" \l "ixzz3KpqkJWKI) [http://www.differencebetween.net/science/difference-between-evaporation-and-boiling/#ixzz3KpqkJWKI](http://www.differencebetween.net/science/difference-between-evaporation-and-boiling/" \l "ixzz3KpqkJWKI)

**The Theory**

**What are liquids?**

Liquids are one of the three states of matter. They are able to flow and occupy the shape of the container.

**What happens when a liquid is heated?**

As a liquid is heated, its temperature increases. As its temperature increases, the molecules of the liquid gain energy and their kinetic energy increases.  As the kinetic energy increases, the molecular motion increases and the molecules of the liquid overcome the force of attraction between them.

On continuous heating, a particular temperature is reached where the molecules of the liquid leave the surface in the form of vapour. This produces a pressure above the liquid equal to the atmospheric pressure and the liquid starts boiling.

At this stage, the temperature of the liquid remains stationary even on further heating. This stationary temperature at which the vapour pressure of the liquid is equal to the atmospheric pressure is called the boiling point of that liquid. At this temperature, bubbles begin to form and rise in the liquid. Before reaching this temperature,  The bubble is not forming because the atmospheric pressure is greater than the pressure in the bubbles and they collapse.

**Can you define the process of evaporation and boiling?**

Evaporation and boiling are two different processes. Evaporation is a process where liquid is converted into gas at any temperature below its melting point. Boiling is the process in which liquid is converted into vapour at its boiling point. Evaporation is a surface phenomenon, whereas boiling is a bulk phenomenon. Evaporation is the gradual vaporisation of a liquid on the surface Whereas the boiling is the rapid vaporisation of a liquid when it is heated to its boiling point. Below the boiling point, a liquid evaporates from its surface. At the boiling point, vapour bubbles come from the bulk of the liquid.

At an atmospheric pressure of exactly 760mm Hg (1 atm), the temperature at which a liquid boils is called the normal boiling point of the liquid. For water, the vapour pressure reaches the standard atmospheric pressure of 1 atmosphere at 100°C. So the normal boiling point of water is 100°C (212°F or 373K).The boiling point of pure water increases on the addition of soluble substances such as sugar or common salt. Boiling point of pure water increases with increase in pressure.

The quantity of heat required to completely vaporise a unit mass of a liquid gas at its boiling point is called latent heat of vaporisation of the liquid. It is represented by the symbol **L**. In the case of water the Latent heat of vaporisation is 22.57 x 105 J/kg at 100°C.

**What are the factors that affect the boiling point of a liquid?**

**Pressure:** If the external pressure is higher than one atmosphere, the liquid will boil at a higher temperature than the normal boiling point. Example: In a pressure cooker, we increase the pressure so that the pressure inside the pressure cooker is greater than one atmosphere. So the water in the cooker boils at a higher temperature and food cooks more quickly. Conversely, if the external pressure is lower than one atmosphere, the liquid will boil at a lower temperature than the normal boiling point. Example: At higher elevations, such as hills and mountains, the atmospheric pressure is lower than one atmosphere, so water boils at a lower temperature than the normal boiling point.

**Molecule Types:** Types of molecules in the liquid affect the boiling point of the liquid. If the force of attraction between the molecules is relatively strong, the boiling point will be relatively high. If the force of attraction between molecules is relatively weak, the boiling point will be relatively low.  
The boiling points of some liquids at 1 atmospheric pressure are shown in the table.

|  |  |
| --- | --- |
| **Compound** | **Boiling Point** |
| **Covalent compounds** | |
| Acetone | 56-57°C |
| Benzene | 78-80°C |
| Chloroform | 60-62°C |
| Ethyl alcohol | 78°C |
| Carbon tetrachloride | 76.7°C |
| **Ionic Compounds** | |
| Water | 100°C |
| Nitric acid | ~83°C |
| 10% NaCl solution in water | ~100.5°C |

From the above data, it is clear that, most of the ionic compounds have higher boiling points than the covalent compounds. This is due to the presence of ionic bond in ionic compounds. The addition of salt in water raises its boiling point.

**Learning Outcomes**

1. Students understand the term 'boiling point' through this experiment.
2. Students perform the experiment using water & notice the physical change that happens during the process.
3. Students may be able to design the same experiment with a few more solvents suggested by the teachers.
4. Students realize that temperature remains constant when a liquid boils at its boiling point.