Open, Closed and Isolated Systems in Physical Chemistry

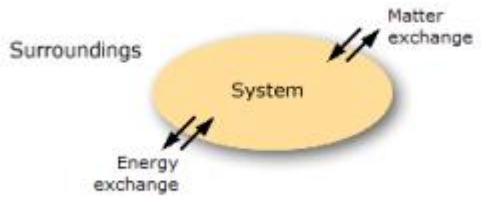
Definitions are the key especially at the beginning of learning a new subject. We define a system as something which we identify or prepare in order to do experiments and make observations. Nothing is perfectly isolated from its surroundings, but we can get quite close even though, eventually, all barriers break down. Thermodynamics and physical chemistry make use of different types of systems which allow interaction or coupling with the surroundings.

System and surroundings

First the definitions:

A system: that part of the universe we wish to study.

The surroundings: the rest of the universe.



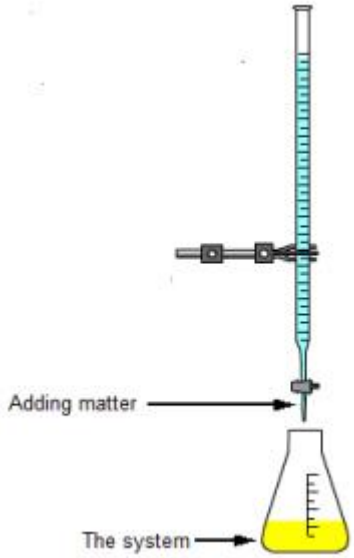
If a system is **isolated**, then nothing can enter or leave. Its energy and matter remain the same. Any changes go on inside the system, and since it is isolated, we cannot know anything about an isolated system from the outside.

We might think of the Earth as a system or we might focus on a chemical reaction. Usually energy and matter can change in a system. Imagine your body as a complex biological system which interacts with the surroundings, or think of the burning of a cookie in a bomb calorimeter. Systems can be complicated or simple. A bomb calorimeter only allows heat to be exchanged. Such a system is called **closed**.

An example of a closed system is a balloon being heated so the gas inside expands it, or a piston like in the movie : no matter is exchange, only heat.

The piston responds to heat changes.

When both matter and energy can be exchanged, the system is called **open**. Clearly when you do a titration matter is added. In this case the system is the beaker.



Interacting with a system

Suppose we have a system which is a drink in a glass. Certainly heat flows in and warms the cold drink, and mass changes when we add to the glass or drink the contents. The system is open.

If you want to cool your drink, you can add some ice and the temperature goes down as the ice cools the drink. If however, we dropped an ice cube into the ocean, there would be no noticeable change.