Lecture 1: Exercise 1

As will be the case with all of the exercises I will start with an explanation of the exercise. Then I will present a hint to help you solve it yourself. Then I will present the solution in detail.

Explanation

This exercise is designed to make you think, more than it is designed to test you. It makes you think like a physicist. The first instruction is to think about what a closed system is. Reread the description in the previous paragraph.

The first task in the exercise is to state the assumptions that need to be made in order to consider something a closed system. This requires you to think about what it takes to meet the definition of a closed system. This is important because physicists need to be able to understand, use, and operate within the constraints of a definition.

The second task is to explain what an open system is. This is another example of using a definition, the trick here is that you have to invent that definition.

Hint

Closure can be thought of as a boundary. You could even think of it in terms of mathematical closure—if you do something to a member of a set, closure requires that it remain a member of the same set. Thus adding to natural numbers results in a natural number, the set of natural numbers is closed under addition. Thus, a closed set includes its boundary. Similarly an open set is one that does not include its boundary.

Answer

The assumptions required to establish a closed system are either

1. The system you are studying is the entire universe and is in the realm of cosmology.

2. The system has no connections to anything other than what you are studying. In reality this is never achievable. However we can decide that connections outside the system are not important to our understanding. We will continue in this way for a long time and then find a previously hidden connection that makes the assumption invalid.

3. We can say that the system is approximately closed and then proceed as if it were closed until we find some reason for it not to be closed. Should this happen we may need to redefine the system so that it can be part of a larger closed system.

An open system can be said to be one that is not closed. In other words there are connections to things outside of the system.