## 1.1 An example of thinking about physics.

The ancient Greek philosophers had the mistaken idea that gravitation was a natural tendency for objects to be attracted to an almost mystical place in the world. This special place was said to be the center of the Earth. The heavier an object was the more strongly attracted it would be to that center. In other words, their weight determined their proper place and they all settled into that place. This was their idea of gravity. Today scientists laugh at that idea, but what tells us that this idea is wrong? What is the right idea?

The fact that the ancient Greek idea of gravity was wrong took a long time to be realized—over a thousand years went by, with brilloiant people studying it every day. It was Galileo that put the proverbial "nail in the coffin" of the Greek idea of gravity. His argument went something like this; note—I will enumerate the arguments so they are easier to follow (this will be a standard procedure for proofs and derivations):

- 1. We will assume that an object that is heavy falls faster than a lighter object as they are each trying to get to their proper place in the world. This explained why it was possible to pick up small objects, but not buildings or mountains—the latter being in their proper places. This is the idea promoted by Aristotle.
- 2. What happens when we strap a lighter object to a heavy one? There are two possibilities; either the combined object acts like a single object, or it does not. This idea is an example of the *law of the excluded middle*. Something either is or it is not, there is no middle where they are both true. These possibilities led to the next two arguments.
- **3.** If the combination forms a single object, that single object is heavier than either of the two components. By the assumption in step 1 the single heavier object must fall faster than the heavier of the two component objects alone.
- **4.** If the combination does not form a composite object, then, by the assumption made in step 1, the lighter object will fall slower than the heavier. Since they are connected by the strap, the lighter object will slow the rate of fall of the heavier object, so the combination will not fall as fast as the heavier object. (indeed, if the strap is even lighter, then it will also make things fall slower).
- 5. These arguments lead to the prediction that the same combination of objects fall both faster and slower than the heavier of the two component objects. A situation where a given assertion leads to two or more opposing outcomes is called a *contradiction*. No assertion that leads to a contradiction can be true. This method of proof is *proof by contradiction*, or *reductio ad absurdum*. Let us say that you are trying to prove an assertion. The first step in a proof by contradiction is to assume your assertion to be false. You then show that this falsehood leads to a contradiction. Since no assertion leading to a contradiction can be true, the falsehood is then itself false. This proves your original assertion cannot be false. By the law of the excluded middle, it must then be true. This completes a proof by contradiction.
- 6. In this case we have proved that Aristotle's assertion that objects fall at a rate according to their weight is false; this is the same as proving that objects fall in a way that is independent of their weight. In fact, this principle is *the law of falling bodies*. To state this law explicitly, objects fall under the influence of gravity independent of their weight. This implies that the influence of gravity is the same for all objects.

7. Having made the prediction that objects fall independently of their weights, experiments were performed that confirmed this result.

This is a fantastic example of the process of physics! We have an established idea, predicted that this idea produced results that were contradictory, thus formulated a new hypothesis and confirmed it by both logical reasoning and physical experiment. We can attempt to answer our question for the chapter: Physics can be defined as the process of establishing an idea about fundamental natural processes, predicting the consequences of that idea, and either confirming or refuting it. But how do we come up with an idea about nature?