— WRITING SAMPLE —
(science)
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ATOMIC & SUB-ATOMIC PHYSICS

Essay #I: The Existence of Atoms

We are all aware of the theoretical existence of atoms, and most of us have some knowledge of how atoms behave. Nevertheless, none of us have ever seen an atom, and it is therefore very important to learn why we believe they exist. Just what are these wonderful objects, and how can we describe them so confidently?

We can begin to answer this question by considering several simple observations that suggest matter consists of particles. One of the most beautiful of these is the existence of crystals. Under certain conditions, a solid may form into wonderful geometric shapes, and the shape is always the same for a given substance. The simplest way to explain this phenomenon is to imagine these crystals to be composed of a tight packing of identical "building blocks." The shape of these individual building blocks might then be the cause of the crystal shape.

Another suggestion for the existence of basic building blocks of matter is a simple observation of certain oil drops on water. When a small amount of such an oil is placed on water, it will spread out until it reaches a very definite area, and then remain at this size. This shows that the oil can be made to spread only so thin before it must break into separate drops. One explanation is that the oil is composed of tiny identical building blocks which will spread out until they lie just one building-block thick.

Another extremely important observation was made by an English Quaker, John Dalton, in 1808. He found that when two substances combine chemically to create a third, the proportion in which this occurs will always be the same. As an example, it was found that eight kilograms of oxygen will always combine with one kilogram of hydrogen, to form water. If more than one kilogram of hydrogen were used, there would be some left over; if less were used, some oxygen would remain.

The simplest explanation of such definite proportions involved the concept of fundamental building blocks. There were certain substances which could never be created by combining others—these were called *elements*, and it was theorized that each element consisted of its own particular kind of fundamental "building blocks," which were called atoms. When two elements combined chemically, it seemed reasonable that their respective atoms would join in a certain definite ratio, and this would result in the definite proportions of the chemical reactions. We call such a combination of atoms a molecule; the corresponding substance is known as a compound. It must be emphasized here that these observations do not prove atoms and molecules exist; they are simply occurrences that can be best explained by an atomic theory.

A further physical observation, known as Brownian motion, suggests that matter may be composed of tiny *moving* objects. When tiny dust or smoke particles are placed in a gas or liquid and observed under a microscope, they are found to move around in a random manner. They move first in one way, and then suddenly change direction in a random, haphazard way. Once again, this observation does not prove anything. However, we can say that by far the simplest explanation of Brownian motion is that it is caused by the random collisions of tiny

moving particles of matter. While these particles themselves are unobservable, they may strike and move larger, observable particles.

We have presented four simple physical observations which can best be explained by considering matter to be composed of tiny particles, and one of these phenomena suggests that these particles are in random motion. We call this explanation the kinetic particle theory of matter. Does it fit in well with our other observations of matter?

Without any question, the answer is yes. In our chapter on thermodynamics, we saw that the kinetic particle theory can predict the behavior of gases, and explains all of the concepts of thermodynamics in terms of simple Newtonian mechanics. Not only does this theory agree with the observed phenomena—it actually simplifies our understanding of matter.

The subject has been considered by the greatest minds of our planet, and none have developed an explanation of matter as simple and useful as the kinetic particle theory. It is true that we cannot see atoms. But we believe in the existence of many things which are not visible. None of us have directly seen the back of our own head! Until recently no man had seen the far side of the moon, yet its existence was completely accepted.

The important point is that atoms exist in the sense that they are the only conceivable explanation of a vast body of observations. Every prediction that the atomic theory has made is correct, and there is no reason to expect the situation to change. This is what we mean when we say, "We believe in atoms." In the rest of this chapter we will be concerned with research based on this belief.

References to bibliography at end of chapter: 5-3; 7-2; 9-4; 11-1; 11-2; 11-31; 11-9; 11-41; 16-19; 16-201; 16-22; 17-1; 19-8; 19-25; 20-11; 20-171; 21-1.

This writing sample is an excerpt from the supplementary textbook *From Above the Web: A New Look at Physics and its Extensions*, first draft manuscript, copyright by the authors: Stephen Arthur, James Atkins, Mark Termes, and Lorne Whitehead. Funded by an OFY grant. Original idea and project proposal by Stephen Arthur. **See flowchart example with excerpt from the Introduction by Lorne Whitehead.** (Dr. Whitehead is Vice-President Academic and Provost of the University of British Columbia as of 2004. He is the founder of TIR Systems and holds a research chair in the UBC Department of Physics.)