Introduction to Thermal Physics

Heat, energy and temperature pervade our lives. Just think about it. We give attention to hot and cold in deciding what we wear during the day, at night and when we go to bed. We think about the topic when deciding how many covers, if any at all, we will wrap in or sleep under at night in order to maintain *the right temperature*. Many of us have heating and cooling systems in our homes, schools and work places that control the temperature during the day and night to keep us as comfortable as possible without spending too much money. We install fans or use portable fans in our homes to keep us comfortable. Most of us have cars equipped with heating and air conditioning systems; some may even have meters in their cars that register the indoor and outdoor temperatures. Many of us watch and listen to weather reports, especially the forecasted temperatures, with great interest so that we can make decisions about what to wear and what to do on the following day.

Our bodies are highly sensitive to hot and cold. We learn very early in life through the University of Pain that we shouldn't touch a hot pot on the stove or a hot light bulb in a lamp. It is a remarkable lesson that makes an impression for a lifetime. In that same university, we learn that we should be careful about mouthing or tasting hot foods. We learn how to use our hands to feel the heat that emanates from such foods and we learn how to blow gently on the food to help cool it down. Those of us with either poor genes or poor dental care (or both) know the pain of cold ice cream hitting a nerve in a tooth cavity. And we all have vivid memories of Mom and Dad sticking a thermometer under our tongue (or elsewhere) to get our body temperature to see if we had a fever. We all know the experience of perspiring - our bodies built-in mechanism of cooling us down when temperatures begin to rise. Our bodies have a narrow range of temperatures that they can maintain. Any departure from this range can result in major consequences, including death.

Hot Issues and Tough Questions

Energy topics have become topics of national and global interests. Politicians and scholars debate topics associated with energy supplies, energy alternatives and the impact of our energy dependencies upon the environment. Global *warming* is a *hot topic* in both national and global circles. As the price of octane gasoline rises at the pump, our interest in energy efficient transportation becomes heightened. Scientists search passionately for alternative fuels which will be cost effective and environmentally friendly. We often hear of an energy crisis or even an energy shortage. Meanwhile, scientists preach about the law of *conservation of energy*, leaving the public confused about how there can be a shortage of something that is *conserved*.

What is heat and where does it come from? How does heating and cooling work? When something cools down, what is it losing or gaining? What is hot and cold? Is heat the same thing as temperature? What is temperature? How does a thermometer measure temperature? What is energy and where does it come from? What is meant by energy conservation? Why do we need this thing we call energy? How do we measure heat and energy? What happens to energy after it is used?

These are among the questions that we hope to shed light upon during this unit (and the next unit) of The Physics Classroom Tutorial. Like the laws of gravity, the unwritten laws of heat and energy seem to govern the thermal behavior of our bodies and those objects around us. We wish to understand these behaviors and the laws that seem to govern them. Our understanding needs to be both *macroscopic* and *particulate*. The patterns that are observed with regard to temperature, heat and energy can be explained if we think about matter at the particle level. We will learn that the behavior of atoms and molecules - the building blocks of matter - are the basis for understanding heat and energy. To put it simply, matter consists of little *bangers* and *wigglers*. These particles - bangers and wigglers - are in constant motion. They bang against each other and against the walls of the container. And they also wiggle about a fixed position. The behaviors we observe - the macroscopic level - are explained by the behaviors we can't observe - the behavior of the *bangers* and *wigglers* at the particle level. Our effort throughout this chapter (and the next) is to understand the observed patterns of thermal behavior and to explain such patterns in terms of the particles that such matter is made of.