

1. Matter is made of atoms. Explain how these atoms are related to existence of compounds within matter. If you had a sample of a pure element, what would need to be true of the atoms in the sample?

Answer: Atoms can interact to form molecules that will hold together for some amount of time. These molecules can be made of only one type of atom or of more than one type of atom. A collection of molecules made up of more than one type of atom is a compound.

In a pure element the molecules would be made up of only one type of atom.

2. Most commonly, materials in nature are not pure substances but are mixtures. Speculate on why you feel that might be. Would it have anything to do with the second law of thermodynamics?

Answer: The substances found naturally on earth are the result of normal processes that have been occurring since the planet was formed. Overall these processes are spontaneous and are controlled by the laws of thermodynamics. The second law of thermodynamics states that in spontaneous processes entropy (i.e., disorder) increases. One way to increase entropy is to mix substances and make them less pure. Natural substances mix and normally remain mixed in nature.

3. Explain the difference between a homogeneous and a heterogeneous mixture.

Answer: Homogeneous mixtures have the same composition no matter where in the mixture one looks while heterogeneous mixtures have varied composition from place to place in the mixture.

4. Explain why many of the techniques of modern chemistry were developed by the alchemists rather than the Greek philosophers.

Answer: The Greek philosophers mainly thought about the processes of nature but did little to experiment on the world around them. The alchemists on the other hand were interested in making actual changes to matter. As a result of their interest in matter and its conversions, they developed processes to handle and convert chemical substances some of which are still used today.

5. What are some of implication of the law of the conservation of matter on modern society?

Answer: The Law of the Conservation of Matter says that matter can neither created nor destroyed, so any physical matter used by humans must come from somewhere and must go somewhere. If we don't recycle, then we are constantly trying to get new supplies of raw materials, often with little regard to the environmental disruption of doing so. Conversely any waste products we wish to dispose of will end up someplace in some form no matter how you try to get rid of it. The substance of that material will not go away but will end up in the air, the water, the ground, or somewhere on earth.

6. How is entropy related to order, disorder, and the amount of information required to describe some sample of matter.

Answer: Entropy is generally said to increase as disorder increases. Situations which constitute an increase in disorder are not always obvious. The safest way to indicate increases in entropy or disorder is to observe that as entropy and disorder increase the amount of information needed to describe the state increases.

7. We have subdivided energy in kinetic energy, heat energy, and potential energy. Consider a steam locomotive from the early part of the 20th century. What kind of energy is involved with each of the following: the coal, the steam, the pistons, and the moving locomotive?

Answer: Coal before it is burned contains chemical energy relative to burning, which is a form of potential energy since it can be released later. Once the coal is burned and water has been made to boil, the steam contains excess heat energy because it is warmer than its surroundings. The steam causes the piston to move which in turn causes the locomotive to move. Since the piston and locomotive are moving, they have kinetic energy.

8. Ultimately from where does the energy come that is used to propel an automobile down the road? Explain.

Answer: With the automobiles that are currently used in the western world, the energy comes from the sun several hundred million years ago. This solar energy was converted into the chemical energy of life and ultimately transferred to the chemical energy of the fuel which propels the car down the road.

9. What are some of the implications of the first and second laws of thermodynamics on how we use energy in modern society?

Answer: Energy conversions are inherently inefficient; hence, it is best to use energy directly, if possible. Some types of energy are lower entropy and higher quality than others. If possible, use high quality energy directly.

Because the use of energy to do work degrades the quality of the energy, it is impossible to reuse all of the energy to do work. Hence, energy cannot be 100% recycled, and we will always need more.

10. Based on the two Laws of Thermodynamics, could you make a perpetual motion machine – that is, a machine that runs continuously without the input of energy? Why or why not?

Answer: No. A perpetual motion machine would always involve moving objects against some amount of force which involves doing work. Energy is required to do work and must come from somewhere as indicated by the First Law of Thermodynamics. However, as the energy is used to create motion the Second Law of Thermodynamics states this energy will become less useful to do work. Therefore, a continuous input of energy will be required to keep the machine moving.