

Exercises for Unit #13: Thermodynamics

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Temperature Exercises

1. What is thermal energy?

2. What does temperature measure?

3. What are the three different scales used to measure temperature?

4. What is absolute zero?

5. If something is hot, what are its molecules doing?

6. In our "Spread It Around" experiment why did the food coloring spread out faster in the hot bowl than in the cold bowl?

7. In which parts of your body do you have your thermal energy antenna?

8. What are the four states of matter (ignoring BEC)?

9. Which states have no bonds between the molecules?

10. Which state has bonds that hold the molecules in a tight matrix?

11. As the temperature increases, what happens to the bonds that allow a substance to go from solid to liquid?

12. What happens to the bonds as a substance reaches its boiling point?

13. What happens to the bonds as a substance reaches its freezing point?

Heat Energy Exercises

1. What is heat?

2. Does heat flow from higher to lower temperature, from lower to higher temperature or does it matter?

3. When I first turn on the shower the shower curtain keeps blowing into my legs. Is this an example of conduction, convection or radiation?

4. When I bite into a pizza, the heat is transferred painfully to the roof of my mouth. Is this an example of convection, conduction or radiation?

5. Someone sits a little too close to me on a bus and I can feel the heat coming off of them. Is this an example of convection, conduction or radiation?

6. My daughter holds my hand as we walk across the street. I can feel heat coming from her hand to mine. Is this an example of convection, conduction or radiation?

7. It's a hot sunny day outside. Am I better off wearing a dark shirt or a light shirt if I want to stay cool?

8. An object's temperature always drops when it loses heat. True or false?

9. What happens to molecules as they change from one state to another?

10. When objects evaporate do they absorb heat or release heat?

11. Why do we sweat when we're hot?

12. Why doesn't temperature change when things are changing state?

13. What is heat capacity?

14. Which would cool down faster, a bottle of maple syrup or a teaspoon of maple syrup?

15. Owwww!! I just burned my mouth on a piece of pizza! The strange thing is the crust is just warm. What happened?

16. When I eat at a fast food restaurant I always eat my fries before the burger since the fries get cold so much faster. Which has a higher heat capacity, the fries or the burger?

17. Why do I fill a hot water bottle with hot water and not just hot air?

Answers to Temperature Exercises

1. Thermal energy is basically the energy of the molecules moving inside something. The faster the molecules are moving the more thermal energy that something has. The slower they are moving the less thermal energy that something has.

2. Temperature measures thermal energy. In other words, temperature measures the amount that the

molecules are moving. Thermometers are speedometers for molecules.

3. Fahrenheit, Celsius, and Kelvin.

4. Absolute zero is a theoretical temperature where molecules and atoms stop moving. This temperature has never been reached in the laboratory but they have come close.

5. Its molecules are moving very quickly.

6. In the hot bowl, the molecules are moving very fast. Since they are moving quickly, they bump into the food coloring molecules more and harder spreading them out faster than in the cold water.

7. Skin.

8. Solid, liquid, gas, plasma

9. Gases and plasma

10. Solid

11. The bonds are forced to stretch and loosen up since the molecules are moving at greater speeds.

12. As a substance reaches its boiling point it changes from a liquid to a gas. As this happens the bonds that are holding the molecules together break allowing the molecules to wander off on their own as a gas.

13. As a substance reaches its freezing point it turns from a liquid to a solid. The bonds tighten up, pulling the molecules into a matrix and forming a nice solid substance.

Answers to Heat Energy Exercises

1. Heat is the movement of thermal energy from one object to another.

2. Heat can only flow from a higher temperature object to a lower temperature object.

3. Convection. The heat from the hot water in the shower heats up the air in the shower. The heated air rises. As the heated air rises, it creates a convection current. Which draws air into the shower and blows the shower curtain into my legs. Many of the winds on the Earth are caused by hot air rising and cold air sinking.

4. This is conduction. The fast moving molecules of the pizza bombard my poor mouth molecules. This, in turn, creates sound energy as I scream "OUCH!".

5. This is radiation. Humans can transfer heat by radiation. The fellow sitting next to me was giving off infra-red radiation.

6. This time it's primarily conduction. The molecules in her little hand are vibrating quickly and causing my molecules to vibrate quicker as well. There is probably some radiation going on as well, but since our hands are touching her molecules can directly affect my molecules.

7. A light colored shirt reflects more infra-red radiation so I'll stay cooler.

8. False.

9. The "bonds" between molecules change. They can either tighten up or loosen up depending on whether the energy is increasing or decreasing.

10. They absorb heat.

11. The sweat absorbs excess heat from the body as it evaporates and cools us off.

12. The energy that's entering the object is being used to change the bonds between the molecules. The molecules have reached their "speed limit". They can't go any faster or slower without changing state.

13. Heat capacity is how much heat an object can absorb before its temperature increases.

14. The teaspoon. The smaller the amount the less heat capacity it has.

15. The cheese has a much higher heat capacity than the crust. So the cheese stays hot much longer.

16. The burger holds onto its heat longer than the fries. The burger has a higher heat capacity.

17. Water has a higher heat capacity so it cools much more slowly than air. A hot air bottle will be cool in a matter of seconds. Hot water will take many minutes to cool down.