

SECTION 1 (PP. 103-109): TEMPERATURE DEPENDS ON PARTICLE MOVEMENT.

Georgia Standards: S8P1c – Describe the movement of particles in solids, liquids, gases, and plasma states; S8CS4b – Use appropriate tools and units for measuring objects and/or substances.

1. All matter is made of moving particles.

The *kinetic theory of matter* states that all the particles of matter are constantly in motion. As a result, all particles have kinetic energy. Particles in solids, liquids, and gases move differently.

- Particles in a solid vibrate in fixed positions, but do not move past each other. Particles in a liquid are not tightly bound to each other, as in a solid, and slide past each other. Particles in a gas are separated by greater distances than those in a solid or liquid.
- All the particles in a substance are not moving at the same speed and can change speeds.
- **Temperature** is the measurement of the average kinetic energy of all particles in an object or location.

2. Temperature can be measured.

The two common temperature scales (*Fahrenheit* and *Celsius*) are based on the physical properties of pure water and are expressed in degrees. A third temperature scale is the *Kelvin* scale, which is an absolute temperature scale. The zero point of the Kelvin scale is **absolute zero**, which is the complete absence of particle movement. Absolute zero is 0 K, which is equal to -273.15°C .

Thermometers measure temperature. Often, the physical property used to measure temperature is expansion or contraction. All gases, many liquids, and most solids expand when temperature increases.

- Thermometers filled with a liquid (alcohol or mercury) measure temperature through the uniform expansion or contraction of the liquid over a wide range of temperatures.
- Thermometers can also measure temperature through electrical resistance, infrared radiation, and the differential expansion of materials.

SECTION 2 (PP. 110-115): ENERGY FLOWS FROM WARMER TO COOLER OBJECTS.

Georgia Standards: S8P2c – Compare and contrast the different forms of energy (heat, light, electricity, mechanical motion, sound) and their characteristics; S8CS4b – Use appropriate tools and units for measuring objects and/or substances.

1. Heat is different from temperature.

Heat, temperature, and thermal energy are closely related, but not the same.

- **Temperature** is the average kinetic energy of particles in a substance or location.
- **Heat** is a flow of energy from an object or location at a higher temperature to an object or location at a lower temperature. The transfer of energy through heat continues as long as the temperature difference exists. When energy is transferred in this way, the thermal energy of either objects or locations changes.

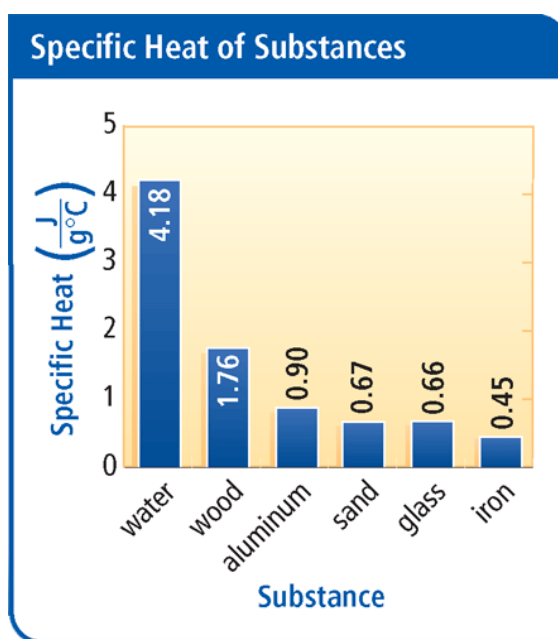
- **Thermal energy** is the total kinetic energy of particles in a substance or location.

The most common units of heat measurement are the calorie and the joule.

- A **calorie** is the amount of energy needed to raise the temperature of 1 gram of water by 1°C.
- A **joule** is the standard scientific unit for measuring energy. One calorie is equal to 4.18 joules, so 4.18 joules of energy raises the temperature of 1 gram of water by 1°C.

2. Some substances change temperature more easily than others.

Each substance needs to absorb a different amount of energy in order for its temperature to increase. A substance's **specific heat** is the amount of energy that is required for 1 gram of that substance to increase in temperature by 1°C.



Any amount of a particular substance has the same specific heat. However, the more mass an object has, the more energy is required to produce an increase in its temperature and, conversely, the more energy must be released to produce a decrease in temperature.

SECTION 3 (PP. 116-123): THE TRANSFER OF ENERGY AS HEAT CAN BE CONTROLLED.

Georgia Standards: S8P2c – Compare and contrast the different forms of energy (heat, light, electricity, mechanical motion, sound) and their characteristics; S8P2d – Describe how heat can be transferred through matter by the collisions of atoms (conduction), or through space (radiation). In a liquid or gas, currents will facilitate the transfer of heat (convection).

1. Energy moves as heat in three ways.

Energy is transferred between objects or locations when there are temperature differences between them. Depending on both the medium and the objects themselves, energy can be transferred by conduction, convection, or radiation.

- **Conduction** is the process through which energy is transferred through physical contact. Particles of a warmer object collide with the particles of a cooler object and transfer some of their energy to the cooler object. Materials that easily transfer energy are **conductors**; those that are poor conductors are **insulators**.
- **Convection** is the process that transfers energy in gases and liquids (**fluids**). Differences in density between substances are produced by differences in temperature. A warmer region of gas or liquid is less dense than a cooler region, due to thermal expansion. The warmer, less dense gas or liquid is pushed up by cooler, denser gas or liquid that sinks underneath. The cycle of convection accounts for currents in bodies of water and winds in the atmosphere.
- **Radiation** is energy that travels as electromagnetic waves, such as visible light, infrared light, and x-rays. All objects radiate at least a small amount of energy. Often, when radiation is absorbed by an object, the transfer of energy as heat occurs. Radiation differs from conduction and convection in that it can transfer energy through a vacuum.

2. Different materials are used to control the transfer of energy.

Materials are used for different purposes depending on whether they are good or poor conductors of energy. Many insulators contain or trap air, which is a poor conductor. Man-made insulators are often based on insulators found in nature.

