What Is Heat?

Paul shivered inside the wood cabin. It was cold outside, and inside the cabin it wasn't much warmer. Paul could hear the rain beating down on the roof. Every few minutes there would be a loud boom, and thunder would shake the cabin walls. Paul was happy to be inside the cabin, safe and dry with his family. "Let's make this cabin warmer," said his father. "Paul, help me build a fire." Paul fetched the firewood and watched as his father carefully stacked the logs in the shape of a pyramid. Paul's father put several small sticks of kindling in the bottom of the pyramid. The kindling would catch on fire much more quickly than the big logs. Paul's father lit the match, and soon the logs crackled and burned in the fireplace, shooting off small sparks. The fire gave off some light, but it also gave off heat. Within 30 minutes the inside of the cabin was warm and toasty. Thanks to the radiation of heat from the fire, Paul wasn't shivering any more.

Though all that Paul's father did was light a match to start the fire, there was a complex set of interactions that had to occur for the fire to ignite and grow. There are three components needed for a fire to successfully burn: fuel, oxygen and a heat source. The matches were the heat source and the logs were the fuel. The oxygen supply came from the air around the fireplace. That's why Paul's father had to pile up the logs as a pyramid, with space in between them. If the logs had been too close together, there wouldn't have been enough oxygen for the fire and it could have fizzled out. A wood fire can grow very quickly. That's why it's so important to be careful when lighting fires and to never leave them unsupervised. A wood fire, like the one in Paul's fireplace, can reach temperatures over 1,000 degrees Fahrenheit. The hottest part of the fire is often the red glowing embers that are left in the fireplace once the wood has burned through. These embers can be as hot as 1,200-1,500 degrees Fahrenheit. Though fire is a common heat source, heat can come from many different sources. Heat can also be transferred from one object to another in a variety of ways.

Scientists use the term "heat" to refer to the energy transferred when two objects or systems are at different temperatures. Heat naturally moves from warmer areas to cooler areas. Think of what happens if you leave a bowl of ice cream out in hot weather. At first, the ice cream is much cooler than the air around it. But if you go back in an hour, the ice cream has melted, and it is roughly the same temperature as the surrounding air. The heat from the air has moved to the ice cream. In this example, the air is the heat source, the place where the higher temperature is found. The ice cream is the heat sink, or the place to which the heat moves. Whenever there is a temperature difference in a system or a group of objects, the heat will naturally move from the heat source to the heat sink.

How does heat transfer from one object to another?

Heat transfers in three different ways: conduction, convection, and radiation. Conduction is the transfer of heat between two surfaces that are directly in contact with one another. When you burn yourself on a hot pan while making scrambled eggs, that's an example of conduction. The heat is transferring from a very hot surface (the frying pan) to a cooler surface (your hand). Heat transfers through some materials better than others. Metals are especially good thermal conductors; that's why pots and pans are made out of metal. Materials that are very slow to transfer heat are called thermal insulators. Some examples of materials that are thermal insulators include rubber and cork. Typically materials that are good thermal conductors – like gold, silver and copper – are also good conductors of electricity.

The second way that heat can transfer is through convection. Convection is the transfer of heat through the movement of large amounts of a liquid or gas. An example of this is the storm outside Paul's cabin. Thunder and lightning are caused when a large mass of hot air meets a large mass of cool air. Warm air tends to rise, and cool air tends to fall. The movement of these air masses and the transfer of energy that occurs are called convection.

The third way heat transfer can occur is through a process called radiation. Radiation is when there is no material transferring the heat. Instead, the energy is carried by electromagnetic waves. Electromagnetic waves come in a wide variety of types: they can be infrared, visible light, UV, or radio waves. The hotter that the object is, the more infrared radiation (and heat) it gives off. The fire that Paul is looking at is radiating heat into the rest of the cabin.

Another example of heat radiation is the sun. At the sun's core the temperature is at least 10 million Kelvin, and on the surface of the sun, the temperature is about 6,000 Kelvin. Kelvin is a form of measurement of heat that scientists use, instead of measuring degrees in Fahrenheit or Celsius. What does 10 million Kelvin actually feel like? It's about 30,000 times as hot as boiling water. All of that heat travels from the sun to the earth on electromagnetic

waves. To reach the earth's surface, the waves must travel through 93 million miles of our solar system. When the radiation arrives from the sun to the earth, it causes the ground to heat up. An object that is especially good at radiating heat is called a blackbody. The sun is a perfect example of a blackbody.

The earth is also a blackbody – it doesn't just absorb heat from the sun's electromagnetic waves; the earth also radiates heat out into space. Some of the heat that the earth radiates is the same energy from the sun. Around 30% of the electromagnetic waves that arrive from the sun are bounced back into outer space by the earth. The rest of the electromagnetic energy is either absorbed by the earth's atmosphere or heats the surface and oceans of the earth.

Name: _____ **Date:** _____

1. What do Paul and his father build in the cabin?

A) a radio
B) a clock
C) an engine
D) a fire

2. What does this passage explain?

A) This passage explains what a wood cabin is and how to build one.
B) This passage explains what heat is and how it moves from one object to another.
C) This passage explains what UV radiation is and why it can be harmful to people.
D) This passage explains what oxygen is and how the human body uses it to survive.

3. Heat moves from warmer areas to cooler areas.
What evidence from the passage supports this statement?

A) Heat moves from the hot fire Paul and his father build to the cold air of the cabin.
B) A wood fire can reach temperatures of more than 1,000 degrees Fahrenheit.
C) After Paul fetches firewood, his father carefully stacks it in the shape of a pyramid.
D) 10 million Kelvin is a temperature about 30,000 times as hot as boiling water.

4. What is an example of a heat source?

A) rubber
B) oxygen
C) thunder
D) the sun

5. What is this passage mainly about?

A) a wood cabin
B) convection
C) heat
D) the relationship between a boy and his father

6. Read the following sentence: "Heat can also be **transferred** from one object to another in a variety of ways."
What does the word **transferred** mean?

A) broken
B) trapped
C) moved
D) planned

7. Choose the answer that best completes the sentence below.
Heat is transferred in three different ways, _____ conduction, convection, and radiation.

A) instead
B) namely
C) in conclusion
D) meanwhile

8. What is radiation?

9. What are two examples of radiation mentioned in the passage?

10. Using information from the passage, explain how a fire makes someone warmer.