Transfer of Thermal Energy
Physical Science

Name: ____________________ Grade: ___ Class Period: ___ Date: __________

Essential Question: What is thermal energy and how is it transferred?

Instructions: Read the selection and answer the questions.

The heat source for our planet is the sun. Energy from the sun is transferred through space and through the earth's atmosphere to the earth's surface. Since this energy warms the earth's surface and atmosphere, some of it is or becomes heat energy. There are three ways heat is transferred, into the atmosphere:

1. radiation  2. Conduction  3. convection

Radiation
If you have stood in front of a fireplace or near a campfire, you have felt the heat transfer known as radiation. The side of you nearest the fire warms, while your other side remains unaffected by the heat. Although you are surrounded by air, the air has nothing to do with this transfer of heat. Heat lamps, that keep food warm, work in the same way. Radiation is the transfer of heat energy by electromagnetic radiation.

Most of the electromagnetic radiation that comes to the earth from the sun is in the form of visible light. Light is made of waves of different frequencies. The frequency is the number of instances that a repeated event occurs, over a set time. In electromagnetic radiation, the frequency is the number of times an electromagnetic wave moves past a point each second.

Our brains interpret these different frequencies into colors, including red, orange, yellow, green, blue, indigo, and violet. When the eye views all these different colors at the same time, it is interpreted as white. Waves from the sun which we cannot see are infrared, which have lower frequencies than red, and ultraviolet, which have higher frequencies than violet light.

Most of the solar radiation is absorbed by the atmosphere and much of what reaches the earth's surface is radiated back into the atmosphere to become heat energy. Dark colored objects such as asphalt absorb more of the radiant energy and warm faster than light colored objects. Dark objects also radiate their energy faster than lighter colored objects.

Conduction
Conduction is the transfer of heat energy from one substance to another or within a substance. Have you ever left a metal spoon in a pot of soup being heated on a stove? After a short time the handle of the spoon will become hot. This is due to transfer of heat energy from molecule to molecule or from atom to atom. Also, when objects are welded together, the metal becomes hot (the orange-red glow) by the transfer of heat from an arc. This is called conduction and is a very effective method of heat transfer in metals. However, air conducts heat poorly.

Convection
Convection is the transfer of heat energy in a fluid. This type of heating is most commonly seen in the kitchen when you see liquid boiling.

Air in the atmosphere acts as a fluid. The sun's radiation strikes the ground, thus warming the rocks. As the rock's temperature rises due to conduction, heat energy is released into the atmosphere, forming a bubble of air which is warmer than the surrounding air. This bubble of air rises into the atmosphere. As it rises, the bubble cools with the heat contained in the bubble moving into the atmosphere.

As the hot air mass rises, the air is replaced by the surrounding cooler, more dense air, what we feel as wind. These movements of air masses can be small in a certain region, such as local cumulus clouds, or large cycles in the troposphere, covering large sections of the earth. Convection currents are responsible for many weather patterns in the troposphere.

infohost.nmt.edu/~klathrop/ES/Earthsystems/Worksheets
QUESTIONS:

1. Radiation is the only type of energy that can travel through space. The Earth gets its heat from what source?

2. What are the three ways in which heat is transferred?

3. How is heat energy transferred in radiation?

4. What does it mean by frequency?

5. How do our brains interpret the different frequencies of visible light?

6. What color do we see when we see all the different spectrum or colors at the same time?

8. Which can absorb more radiant energy, dark colored objects or light colored objects?

9. What is conduction?

10. How is heat transferred in conduction?

11. Which can conduct heat faster, metal or air (gas)? Explain your answer. Think!

What is a Fluid?
A fluid is anything that would spill or float away if it weren't in a container (unless it's big enough to be held together by gravity like a star). If you can stir it up with a spoon or blow it through a straw, it's a fluid. Water is a fluid and so is air. In fact, all liquids and gases are fluids. In space and inside stars there's also another kind of fluid called a plasma.

12. What is convection?

13. How is heat transferred in convection?

14. Give examples of fluid.

15. What is responsible for the weather patterns in the troposphere?

Radiation is energy that travels in waves. The intensity of the energy depends on the size or amplitude and frequency of the waves. Study the chart of the electromagnetic spectrum and answer the following questions.
The Electromagnetic Spectrum

16. What is the range of wavelengths for visible light? _______________ nm

17. What is the range of frequencies of visible light? __________________

18. Which color of visible light has the longest wavelength? ______________

19. Which color of visible light has the shortest wavelength? ______________

20. Which has more energy low frequency or high frequency? _____________

21. What can produce gamma rays? ________________________________

The diagram below shows the frequency and wavelength of various types of electromagnetic energy.

22. Which type of electromagnetic wave has a wavelength of approximately 10-10 meters and a frequency of 1018 hertz?
   - radar
   - X ray
   - radio
   - infrared

23. Which of the following aspects of electromagnetic radiation best explains why electromagnetic radiation is both useful and harmful to humans?
   A. Electromagnetic radiation can be described in terms of both wavelength and frequency.
   B. Electromagnetic radiation travels at the speed of light.
   C. Electromagnetic radiation can travel through a vacuum.
   D. Electromagnetic radiation is energy and can interact with matter.
The diagram shows the electromagnetic spectrum and some of the different types of radiant energy.

24. The component of the spectrum between ultraviolet light and infrared light interacts with the human eye allowing us to see. What is this part of the electromagnetic spectrum called?
   - communication waves
   - x-rays
   - microwaves
   - visible light

25. The sun emits all the different types of radiant energy on the electromagnetic spectrum. The Earth does not receive the full impact of all this radiation. The ozone layer in the Earth’s atmosphere absorbs and helps to block which type of radiant energy?
   - x-rays
   - Ultraviolet light
   - Infrared light
   - Radio waves

26. Scientists have divided the energy in the electromagnetic spectrum in different categories. Each category is defined by a different ___.
   - visibility
   - ray
   - spectrum
   - wavelength

27. As the frequency of the radiation increases so does the energy in that type of radiation. Which form of radiation has the highest frequency and therefore most energy?
   - gamma ray waves
   - infrared waves
   - ultraviolet light waves
   - radio waves

28. Which letter in the diagram below identifies a wavelength?

29. Which form of solar radiation causes sunburn?
   - X-rays
   - Infrared
   - Visible
   - Ultraviolet

30. In general, good absorbers of electromagnetic radiation are also good ___.
   - refractors of heat
   - radiators of heat
   - reflectors of heat
   - con vectors of heat
The metric system is the world standard for measurement. Not only is it used by scientists throughout the world, but most nations have adopted it as their standard of measurement. All of the measurements done in this course will use the metric system.

**Metric Prefixes**

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http://www.sas.upenn.edu/~rachelmr/xraydiff.html

The **visible spectrum** is the portion of the **electromagnetic spectrum** that is **visible** to (can be detected by) the human eye. **Electromagnetic radiation** in this range of **wavelengths** is called **visible light** or simply **light**. A typical human eye will respond to wavelengths from about **390 to 750 nm**. In terms of frequency, this corresponds to a band in the vicinity of **400–790 THz**.