

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.

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**?

7. 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**?

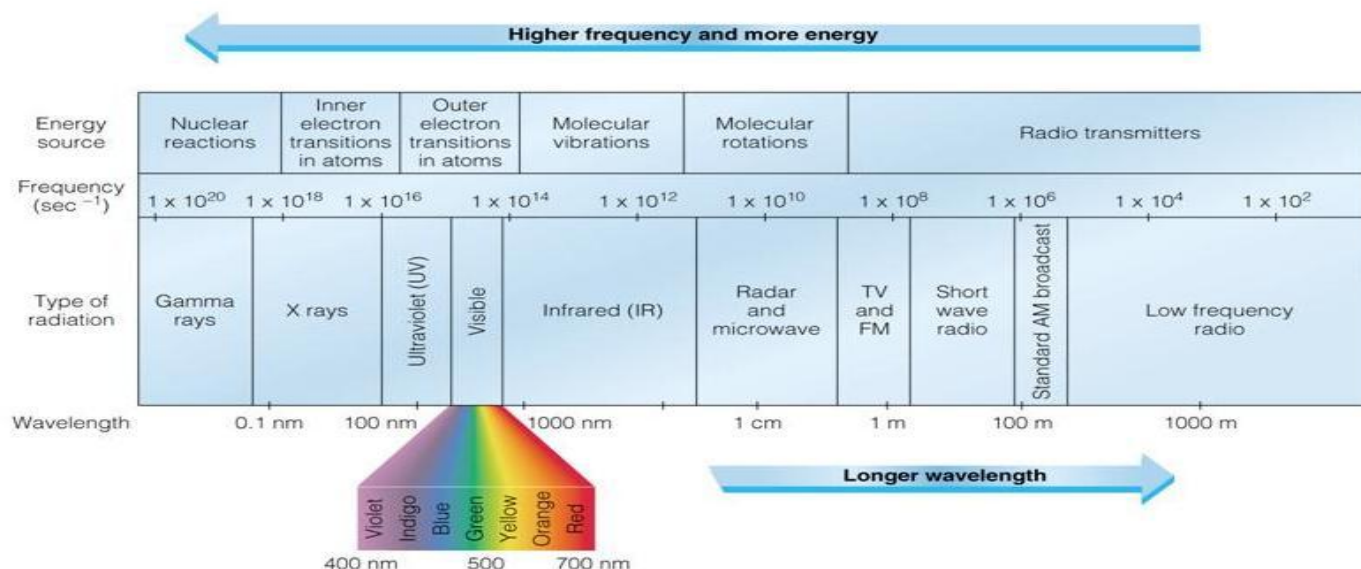
13. How is **heat transferred in convection**?

14. Give **examples of fluid**.

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

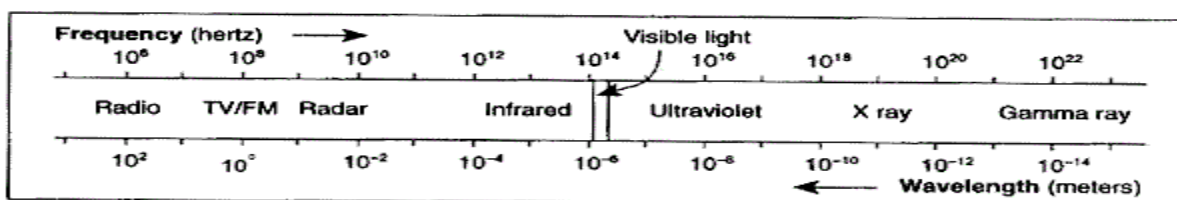
Radiation is energy that travels in waves. The intensity of the energy depends on the size or **amplitude** and **frequency** of the waves. Study the chart of the **electromagnetic spectrum** and answer the following questions.

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**? _____

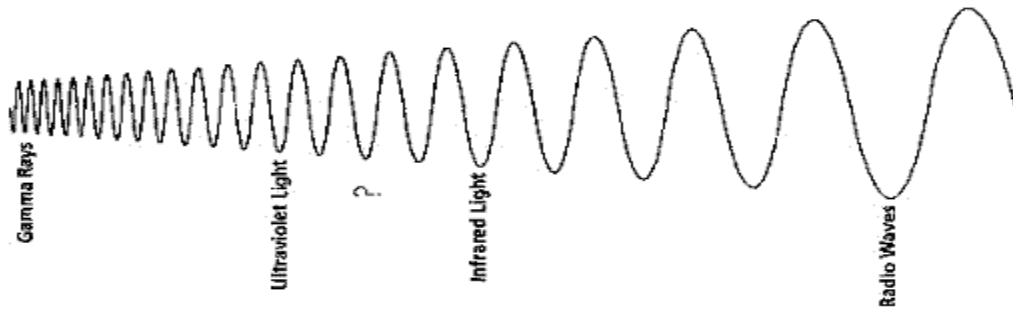
The diagram below shows the frequency and wavelength of various types of electromagnetic energy.



- _____ 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?
 - Electromagnetic radiation can be described in terms of both wavelength and frequency.
 - Electromagnetic radiation travels at the speed of light.
 - Electromagnetic radiation can travel through a vacuum.
 - 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

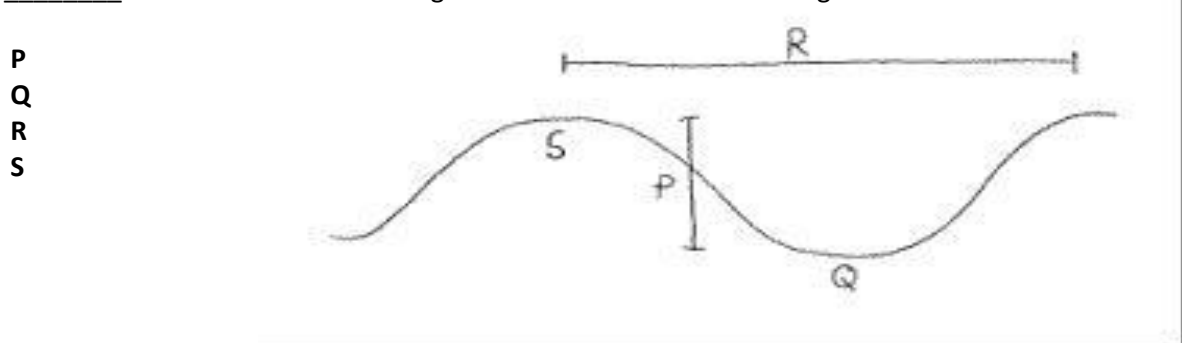
_____ 26. Scientists have divided the energy in the electromagnetic spectrum in different categories. Each category is defined by a different ____.

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 ultraviolet light waves
infrared waves radio waves

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

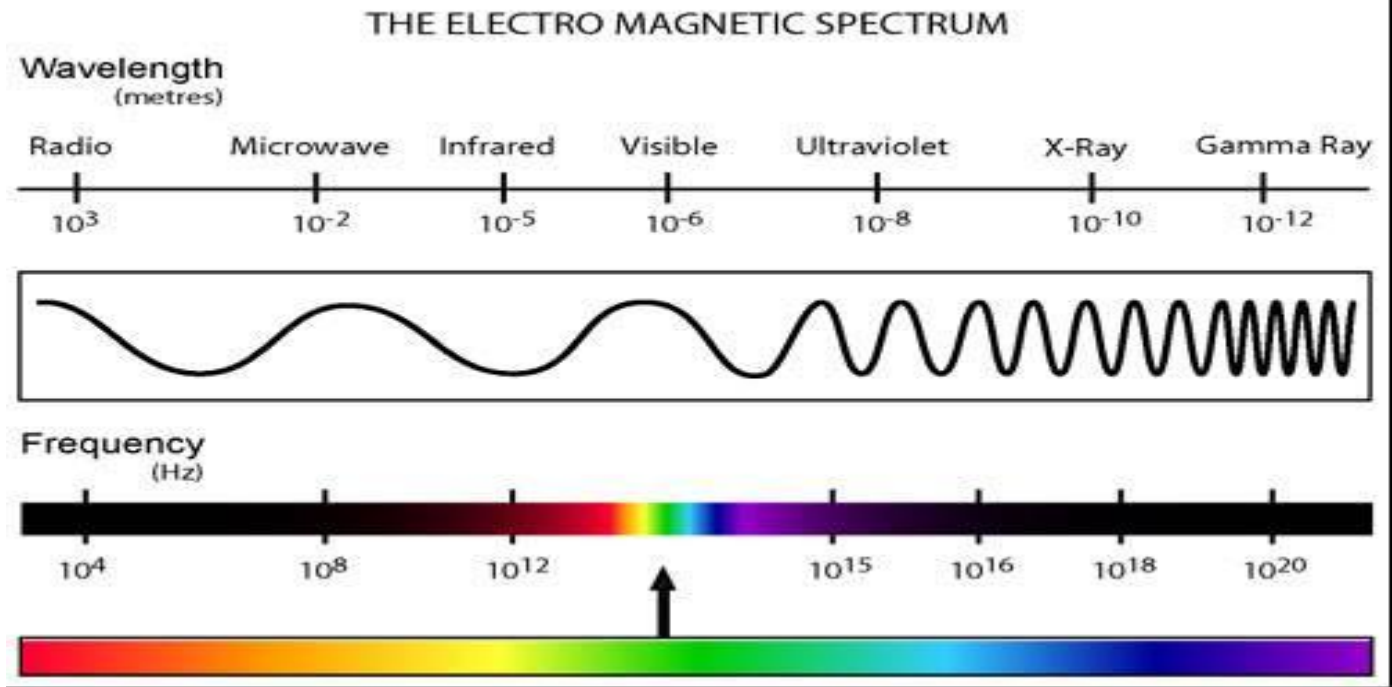


_____ 29. Which form of solar radiation causes sunburn?

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 convectors 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

FACTOR	...or in full ...	or in words	SI PREFIX	SI SYMBOL
1,0E+24	1 000 000 000 000 000 000 000 000	septillion	yotta-	Y
1,0E+21	1 000 000 000 000 000 000 000 000	sextillion	zetta-	Z
1,0E+18	1 000 000 000 000 000 000 000	quintillion	exa-	E
1,0E+15	1 000 000 000 000 000 000	quadrillion	peta-	P
1,0E+12	1 000 000 000 000	trillion	tera-	T
1,0E+9	1 000 000 000	billion	giga-	G
1,0E+6	1 000 000	million	mega-	M
1,0E+3	1 000	thousand	kilo-	k
1,0E+2	100	hundred	hecto-	h
1,0E+1	10	ten	deca-	da
1,0E-1	0,1	tenth	deci-	d
1,0E-2	0,01	hundredth	centi-	c
1,0E-3	0,001	thousandth	milli-	m
1,0E-6	0,000 001	millionth	micro-	μ
1,0E-9	0,000 000 001	billionth	nano-	n
1,0E-12	0,000 000 000 001	trillionth	pico-	p
1,0E-15	0,000 000 000 000 001	quadrillionth	femto-	f
1,0E-18	0,000 000 000 000 000 001	quintillionth	atto-	a
1,0E-21	0,000 000 000 000 000 000 001	sextillionth	zepto-	z

1,0E-24	0,000 000 000 000 000 000 000 001	septillionth	yocto-	y
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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**.^[1] In terms of frequency, this corresponds to a band in the vicinity of 400–790 **THz**.