



# Earth Science!

What is it that you need to get up in the morning, light up your room, get to school, and causes the Sun to shine and other stars to go supernova?

What added to Density creates weather, Earthquakes, volcanoes and tsunamis?



# Earth Science!

## Heat!

Heat is a form of KINETIC energy.

It can be defined as “Molecules in Motion” because that sounds good, but atoms move also.

Every atom in the universe is moving, so every atom has Heat.

And.... What makes a steam locomotive move?

Water molecules moving really fast!



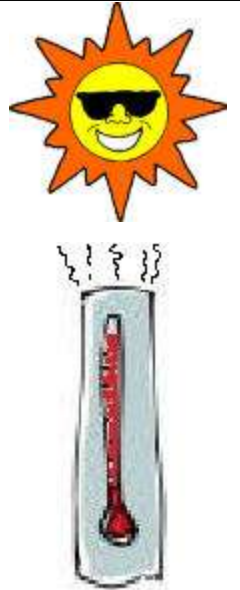
# Earth Science!

## Heat!

“Heat” is the TOTAL amount of kinetic energy you have.

We will measure it in **calories**.

1 **calorie** is the amount of heat it takes to raise the temperature of  
1 ml of water,  
1 degree Celsius



“¡qué calor!”



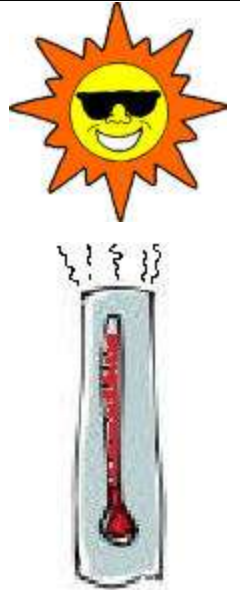
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We talk about how much HEAT we can get from burning a tank of heating oil or the wood in a fire. Some types of firewood have more HEAT than others. Ethanol gives less HEAT than gasoline.

(The Calories in food are really 1,000 calories each)



# Earth Science!

## Temperature!

The “**temperature**” of a substance is the **AVERAGE** speed of the atoms and molecules

If we have 10 molecules of water at 100 degrees Celsius,

And we have 10 molecules of water at 0 degrees Celsius,

What would the **AVERAGE** Temperature be??

What would the **TOTAL** Heat be??

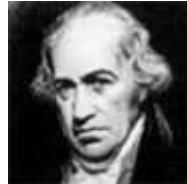


# Earth Science!

## Temperature!

There are 3 common scales for measuring temperature:

Daniel Gabriel *Fahrenheit* (1686–1736)



Fahrenheit

Anders *Celsius* (1701–1744)



Celsius

William Thomson, Lord Kelvin (1824 – 1907)



Kelvin

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Water Freezes	32° F	0° C	273 K
Water Boils	212° F	100° C	
Room Temperature	72° F	21° C	
Body Temperature	98.6° F	37° C	
Absolute Zero (the atoms are not moving at all!)			0 K



# Earth Science!

## Heat vs. Temperature!

Heat is the **TOTAL** amount of available kinetic energy you have.

Temperature is the **AVERAGE** speed of the atoms and molecules.

A burning paper match has Heat. It also has Temperature.

The **TEMPERATURE** of burning paper is  $451^{\circ}\text{F}$  ( $232^{\circ}\text{C}$ )

1 burning paper match has a Temp. of  $451^{\circ}\text{F}$

100 burning paper matches have a Temp. of  $451^{\circ}\text{F}$

(**the average speed of the atoms is the same**)

But 100 burning paper matches have 100 times the **HEAT**  
(**TOTAL** kinetic energy) of 1 burning paper match.



# Earth Science!

## Transfer of Heat!

Heat can be transferred (given away) in 3 different ways:

In **CONDUCTION**, heat is passed from molecule to molecule through collisions. Touching is required.

No touch,  
no transfer  
by conduction.





# Earth Science!

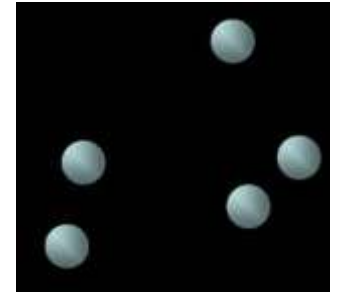
## Transfer of Heat!

Heat can be transferred (given away) in 3 different ways:

In **CONVECTION**, heat is passed when hot fluids (liquids and gases) rise and cool fluids sink. This is caused by **DENSITY**. (They go up and down like in an **elevator**).



Since **HEAT** is molecules in motion, the hotter something is, the faster the molecules are moving. They spread out and the stuff is less dense.



**Denser**

Less dense floats on top of more dense, remember?

**less dense**

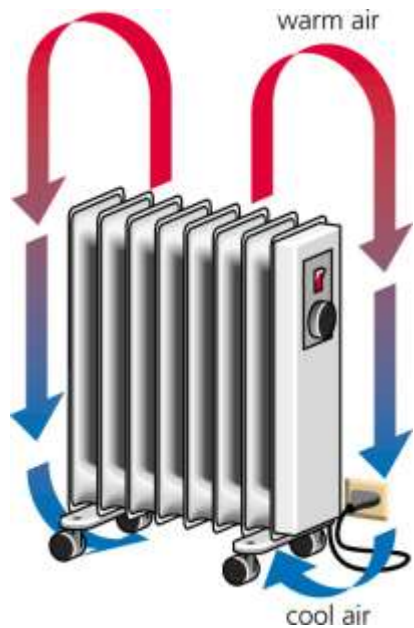


# Earth Science!

## Transfer of Heat!

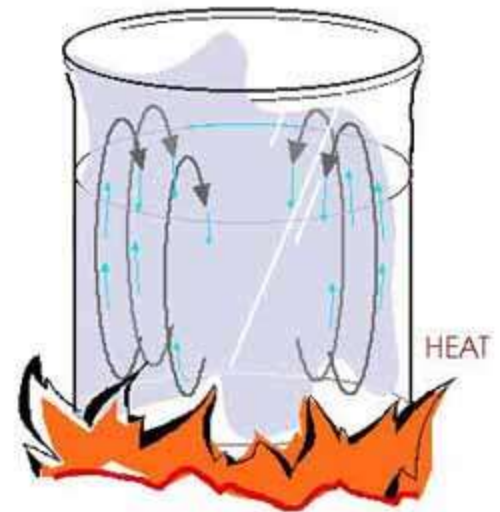
Heat can be transferred (given away) in 3 different ways:

In **CONVECTION**, heat is transferred when hot stuff rises and cool stuff sinks. This is caused by **DENSITY**.



We end up with  
**Convection Currents:**

[video of air currents](#)



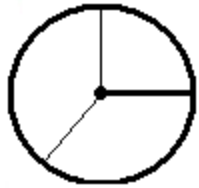


# Earth Science!

## Transfer of Heat!

Heat can be transferred (given away) in 3 different ways:

In **RADIATION**, heat spreads out in every direction – it “radiates” as electromagnetic waves.



Radius

Radiation is the only way that energy can be transferred through empty space. That means that we can enjoy the Sun’s rays here on Earth.



How can astronauts talk to people on Earth?

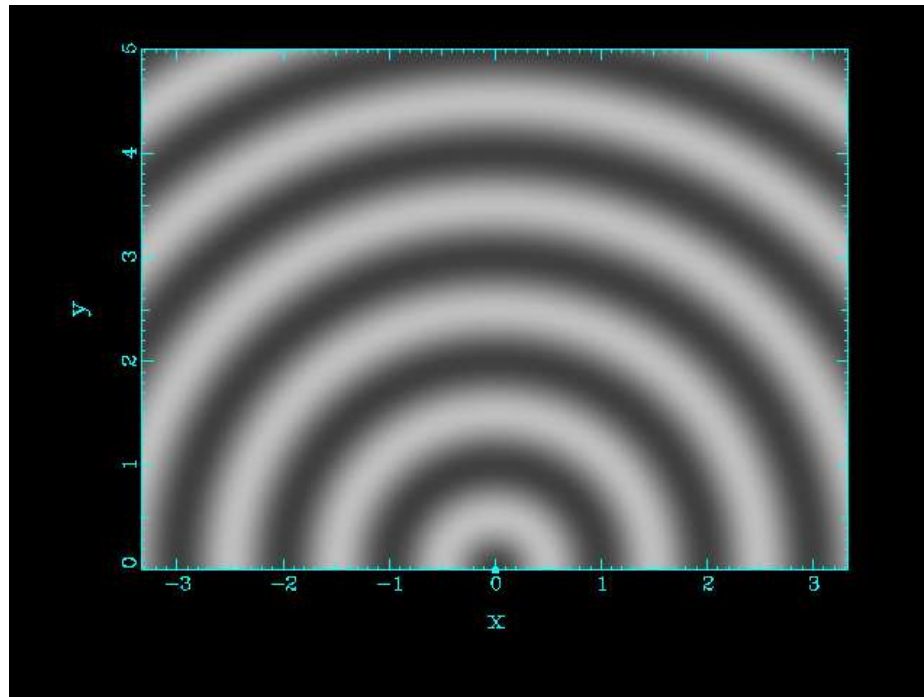
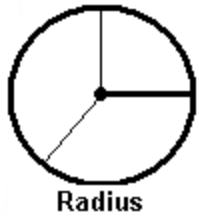


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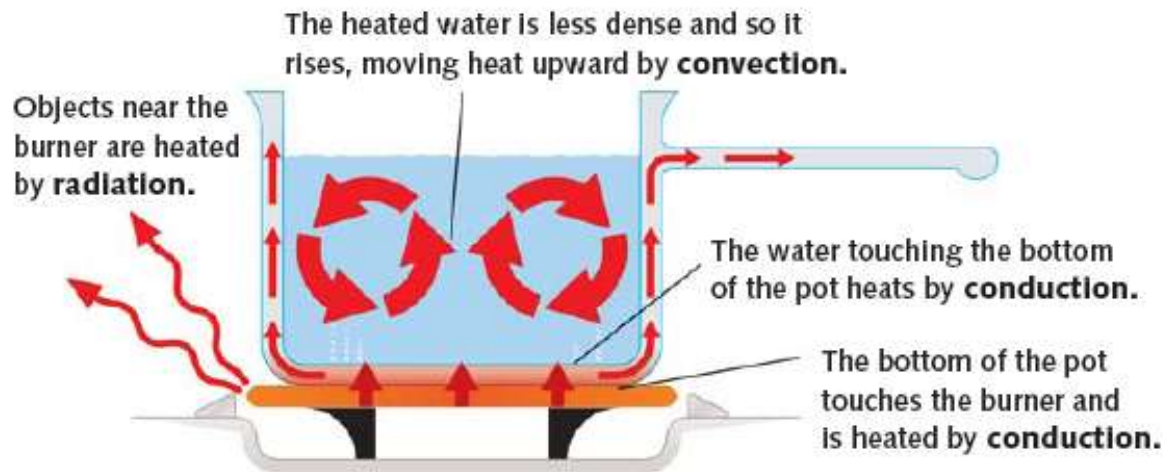
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# Earth Science!

## Heat!





# Earth Science!

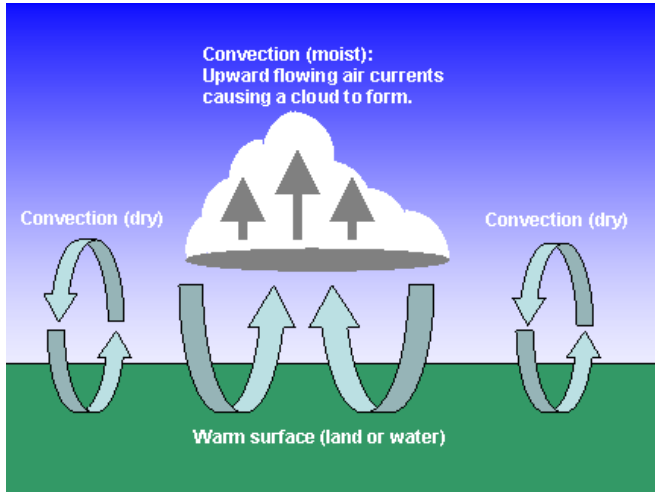
## Transfer of Heat!

- You burn your feet on hot sand – that is \_\_\_\_\_
- You feel the warmth of the Sun on your face on a cold winter day. That is \_\_\_\_\_
- The water is heated on the bottom of the pot by \_\_\_\_\_
- Then the hot water rises, while the cold water on top sinks. That is \_\_\_\_\_
- A puppy sleeps in front of a fire. It feels the warmth because of \_\_\_\_\_
- Which has more HEAT: a cup of boiling water, or a bathtub full of cold water?



# Earth Science!

## So What? Why Bother?



Our weather is caused by radiation, conduction, and convection currents, as warm air boils up!

Earthquakes, volcanoes, tsunamis are all caused by convection currents Inside the Earth!

