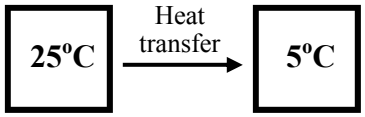
Name: _____

Period: _____

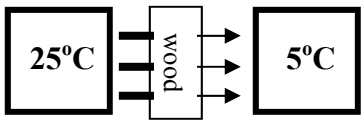
Thermodynamics

Thermodynamics is the study of how heat moves.

Heat always transfers from **hot to cold**. Heat does not rise (hot air rises).

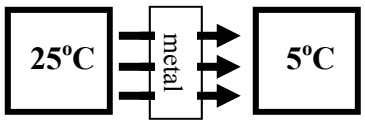


Insulators slow down heat transfer. Materials with air pockets are good insulators.



slow transfer

Conductors easily allow heat transfer. Most metals are good conductors.

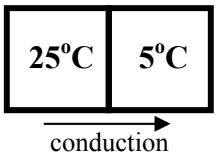


fast transfer

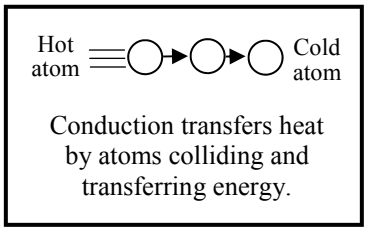
Thermal energy (heat) is transferred in three ways: Conduction; Convection; Radiation.

Conduction

Conduction transfers heat through objects touching.



All atoms are vibrating (moving), which means they have kinetic energy. Hot atoms have more E_k. When hot atoms bump into cold atoms they transfer some energy.



Conduction transfers heat by atoms colliding and transferring energy.

Heat transfer continues until both objects are at ***thermal equilibrium***: the same temperature.

Closer atoms mean more collisions. So solids *tend* to transfer heat better than liquids or gases. Gases tend to make good insulators. Sometimes, though a liquid (water) can speed up conduction with an insulator (your skin).

High density ⟷ *Low density*

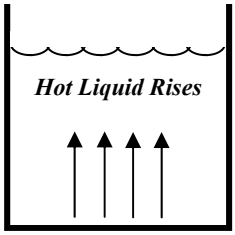
Solid **Liquid** **Gas**

Better conductors ⟷ *Better insulators*

Convection

Convection transfers heat through moving currents in gases or liquids.

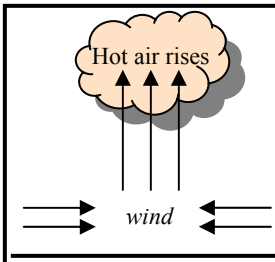
No currents—No convection



Hot liquids (and gases) are less dense and rise, causing ***convection currents***. These currents transfer heat throughout the liquid (or gas).

Gases transfer heat poorly through conduction. Convection currents speed up thermal transfer.

Convection currents can only happens in gases (like air) or liquids (like water), not in solids because solids can't move.

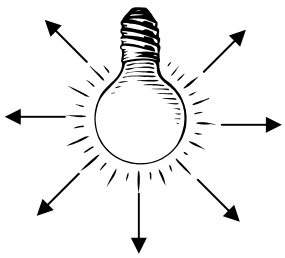


Cold air is pulled in causing wind.

Much of the weather on earth comes from convection currents. The sun warms air at the surface of the earth. Warm air rises, causing winds. When the air cools it falls back to the ground.

Radiation

Radiation transfers heat through electromagnetic radiation; occurs even in a vacuum (empty space).



Radiation transfers heat through electromagnetic waves — pure thermal energy.

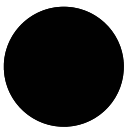
Radiation transfers heat in all directions—even down. Convection currents always rise.

Radiation requires no contact—convection and conduction require touching.

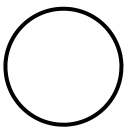
Radiation can go through transparent materials (barriers) like glass.

All energy on earth comes originally from the sun. Space is a vacuum (no matter at all). So only radiation can travel through space to the earth.

Dark objects absorb more radiation than light objects.
Dull objects absorb more radiation than shiny objects.



High absorption of radiation. Heats fast.



Low absorption of radiation. Heats slowly.

Name: _____

Period: _____

1. Conduction	A. Heat transfer through electromagnetic waves.
2. Thermal Equilibrium	B. Thermal (heat) transfer by the contact (touching) of two objects.
3. Radiation	C. Transfers heat by moving currents in gases and liquids.
4. Wind	D. When two objects are at the same temperature.
5. Convection	E. The study of how heat moves.
6. Thermodynamics	F. Caused by convection currents in the earth's atmosphere.

1. Insulator	A. A region of space that contains no matter.
2. Conductor	B. Allows convection, but is a very good insulator.
3. Vacuum	C. Any material that easily allows heat to move through it.
4. Solid	D. Allows convection; can be a good conductor of heat.
5. Liquid	E. Any material that resists the movement of heat through it.
6. Gas	F. No convection can occur in this.

What Kind of Thermal Transfer?
1. Conduction; 2. Convection; 3. Radiation

____ When hot air rises.

____ When two objects are touching.

____ When nothing is touching.

____ When atoms collide.

____ Transfers heat in all directions.

____ Causes wind.

____ Between a stove and a pot.

____ Within a pan of water.

____ More occurs with dark objects.

____ Through a car's windows at night.

Which of the following are at thermal equilibrium?

A. | 25^oC | 5^oC |

C. | 5^oC | 5^oC |

B. | 25^oC | 25^oC |

D. | 5^oC | 25^oC |

Thermal **I**nsulator or Thermal **C**onductor?

____ Metal	___ Glass	___ A coat
____ Wood	___ A penny	___ Styrofoam
____ Air	___ Water	___ Aluminum

Absorbs heat (heats fast) or **R**eflects heat (heats slowly)?

____ Dark liquids	____ Dull objects	___ Aluminum
____ Clear liquids	____ White paper	___ Styrofoam
____ Shiny objects	____ Black paper	___ Dark car

Draw an arrow for each of the following pair of objects showing the direction of the thermal transfer.

25^oC
10^oC

10^oC	25^oC

25^oC
40^oC

25^oC	15^oC

Does heat rise?

Does hot air rise?

Why?

Is this diagram correct or incorrect and why?

Heat transfer ←

25^oK	15^oK