

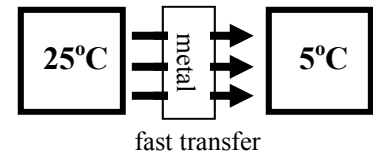
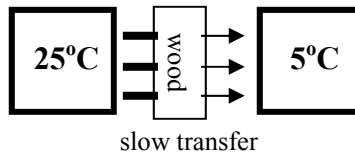
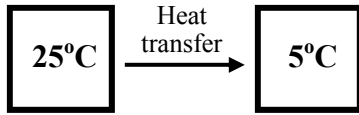
Thermodynamics

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.

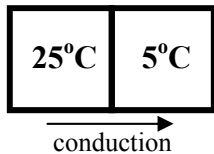
Conductors easily allow heat transfer. Most metals are good conductors.



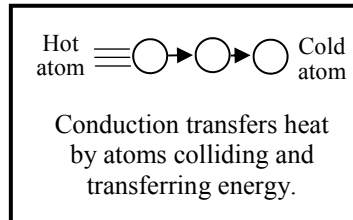
Thermal energy (heat) is transferred in three ways: Conduction; Convection; Radiation.

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.



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

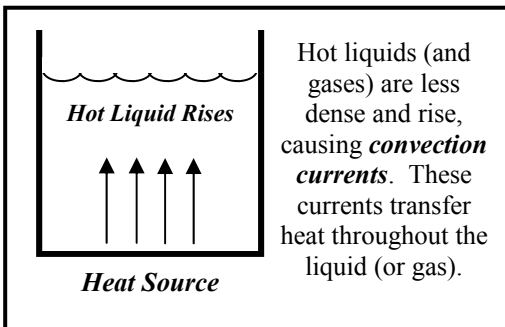
Closer atoms mean more collisions. So solids *tend* to transfer heat better than liquids or gases. Gases tend to make good insulators. Sometimes, though a liquid (water) can speed up conduction with an insulator (your skin).

High density $\longleftrightarrow$ Low density
Solid Liquid Gas
 Better conductors $\longleftrightarrow$ Better insulators

Convection

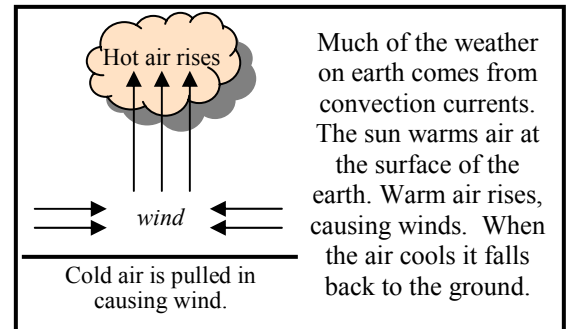
Convection transfers heat through moving currents in gases or liquids.

No currents—No convection



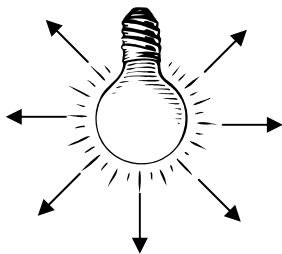
Gases transfer heat poorly through conduction. Convection currents speed up thermal transfer.

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



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.

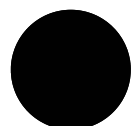
Radiation requires no contact—convection and conduction require touching.

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

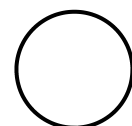


All energy on earth comes originally from the sun. Space is a vacuum (no matter at all). So only radiation can travel through space to the earth.

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 2. Thermal Equilibrium 3. Radiation 4. Wind 5. Convection 6. Thermodynamics	A. Heat transfer through electromagnetic waves. B. Thermal (heat) transfer by the contact (touching) of two objects. C. Transfers heat by moving currents in gases and liquids. D. When two objects are at the same temperature. E. The study of how heat moves. F. Caused by convection currents in the earth's atmosphere.	1. Insulator 2. Conductor 3. Vacuum 4. Solid 5. Liquid 6. Gas	A. A region of space that contains no matter. B. Allows convection, but is a very good insulator. C. Any material that easily allows heat to move through it. D. Allows convection; can be a good conductor of heat. E. Any material that resists the movement of heat through it. F. No convection can occur in this.
What Kind of Thermal Transfer? 1. Conduction; 2. Convection; 3. Radiation		Which of the following are at thermal equilibrium?	
_____ 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.		A. 25°C 5°C C. 5°C 5°C B. 25°C 25°C D. 5°C 25°C	
Draw an arrow for each of the following pair of objects showing the direction of the thermal transfer.		Thermal <u>I</u> nsulator or Thermal <u>C</u> onductor?	
25°C 10°C 25°C 25°C 10°C 25°C 15°C 40°C		_____ Metal _____ Wood _____ Air _____ Glass _____ A penny _____ Water _____ A coat _____ Styrofoam _____ Aluminum	
<u>A</u> bsorbs heat (heats fast) or <u>R</u> eflects heat (heats slowly)?		<u>A</u> bsorbs heat (heats fast) or <u>R</u> eflects heat (heats slowly)?	
Does heat rise? Does hot air rise? Why?		_____ Dark liquids _____ Clear liquids _____ Shiny objects _____ Dull objects _____ White paper _____ Black paper _____ Aluminum _____ Styrofoam _____ Dark car	
Is this diagram correct or incorrect and why?		Heat transfer ← 25°K 15°K	