Some Basics About the SUN

The Sun in a star! It is the closest star to Earth.

The Sun is about 4.5 billion years old.

If the Sun were a hollow ball, you could fit one million Earths inside.

The Sun is mostly helium and hydrogen gas, held together by gravity.

Each second, the Sun releases as much energy as an explosion of 100 billion tons of TNT. This energy is electromagnetic radiation.

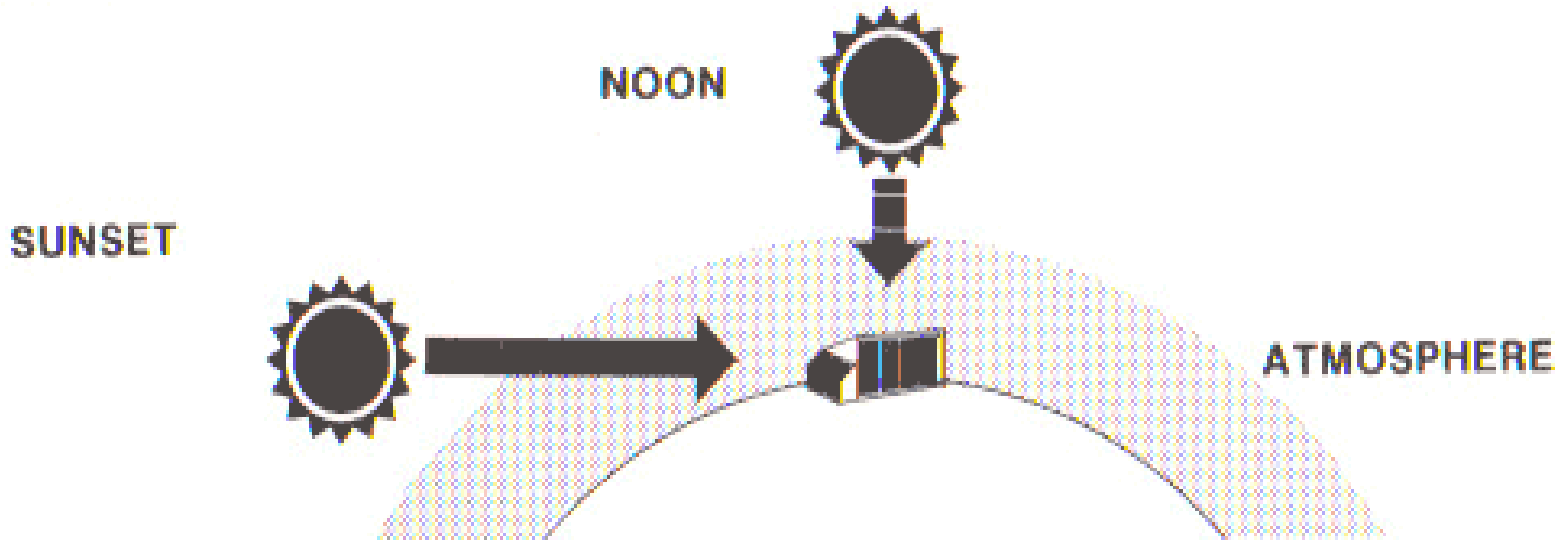
Earth receives only a tiny fraction, one-billionth, of the Sun's energy.

A sunspot is a dark area where the Sun's surface is a little cooler. When the Sun has fewer sunspots, it gives off less energy. This causes Earth to cool down. In the 1600s, when the climate was cooler for a short time (the "Little Ice Age"), people noticed there were no sunspots for several decades.

http://eo.ucar.edu/kids/green/warming2.htm

Some Basics About the SUN

The amount of solar energy reaching the Earth's surface is determined by the amount of atmosphere through which it must pass.



http://www.azsolarcenter.org/

Question

- If more of the sun's energy hits Earth when the air is thin, what does this mean for living in the mountains or the desert?

- At high altitude where there is less air pressure or in a desert where there are fewer water molecules in the air, objects may heat up faster and people may sunburn more quickly. How might air pollution affect this?

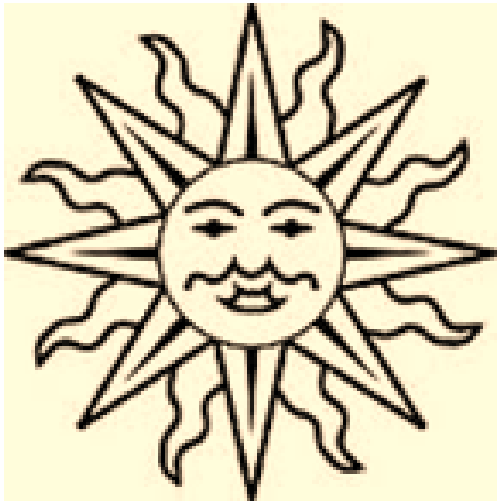
The Earth and the Sun

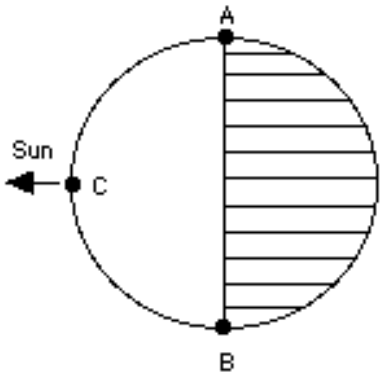
- How often does the Earth make one complete revolution around the sun?
- Approximately 365 days and 6 hours (1 year)
- How often does the Earth make one complete rotation on its axis?
- Every 24 hours (1 day)
  - That's a rate of 1000 mph!

The Earth and the Sun

The sun's energy hits part of the Earth and leaves the rest in shadow.

In this simplified diagram the side left of line AB is day and the right side is night.

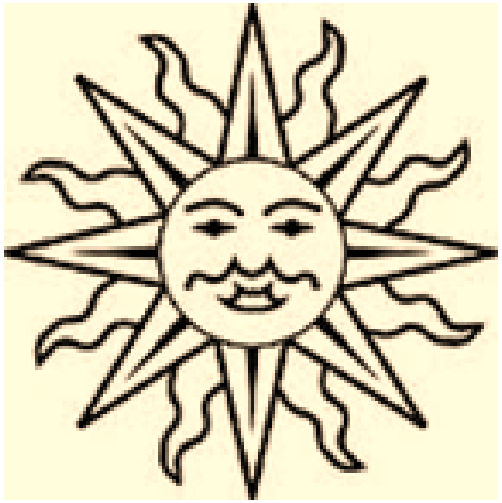


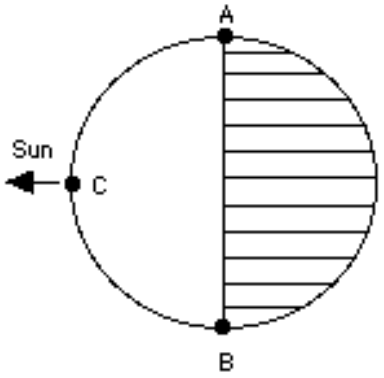


http://www-istp.gsfc.nasa.gov/stargaze/Sseason.htm

Question

- What is missing from this diagram to understand how the sun's energy hits the Earth?

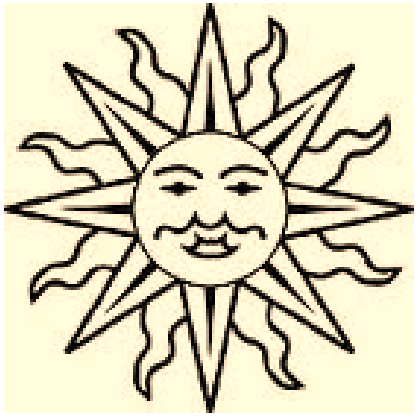


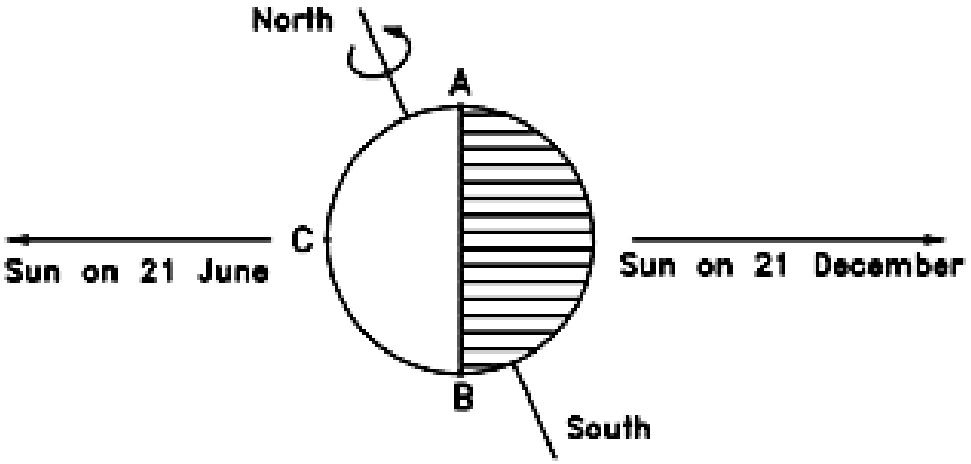


- the angle of the earth's axis

The Earth and the Sun

The Earth's axis always points toward the same area of space - toward the "north star", Polaris.





But, the angle between the Earth's axis and the Earth-Sun line (C) changes throughout the year.

http://www-istp.gsfc.nasa.gov/stargaze/Sseason.htm

The Earth and the Sun

SO…

- Seasons are caused by different lengths of day - different durations of sun radiation at different points on the Earth.
- For example: When day is longer than night north of the equator, the Northern Hemisphere enjoys summer and receives more of the sun's energy.
- The Northern Hemisphere heats up gradually following the longest day of the year, June 21.

Question

- How does day length change at the equator?

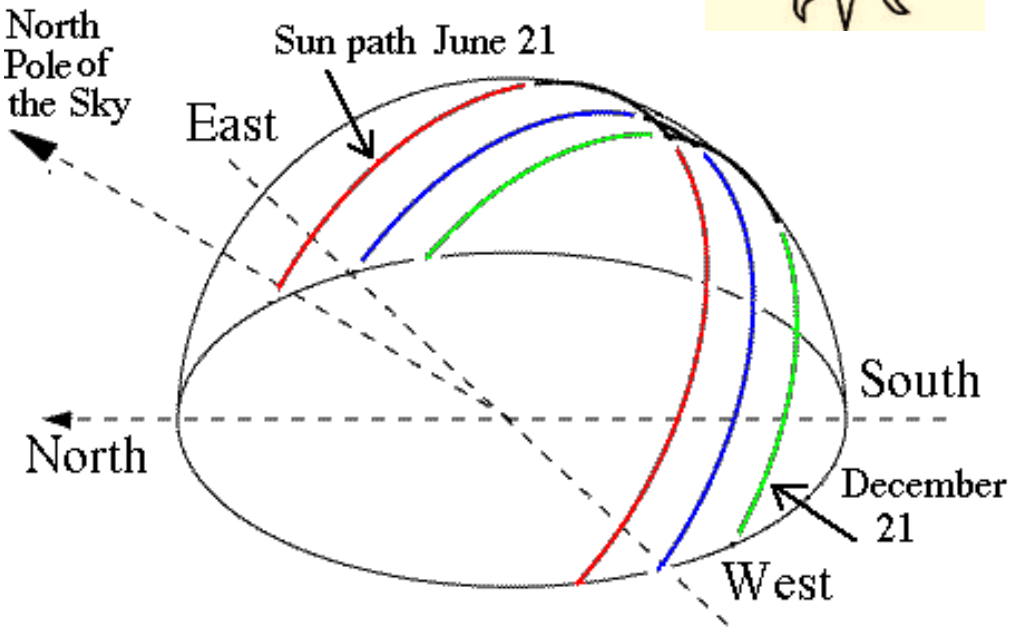
- It doesn't, that's why its called the equator! Seasons at tropical latitudes are caused more by precipitation than by changes in the duration of the sun's radiation.

The Earth and the Sun

- In June the north pole is inclined towards the sun, making the sun seem high in the sky. The sun appears to rise in the Southeast and set in the Southwest.

- In December the north pole faces away from the sun, and it seems low in the sky. The sun appears to rise in the Northeast and set in the Northwest.

Effects of the Sun on the Northern Hemisphere



http://www.niams.nih.gov/

The Earth and the Sun

SO….

- The angle of the sun’s radiation changes with the hour and the season.
- In summer when the sun’s angle is steeper, radiation hits the Earth’s surface more directly.

Question

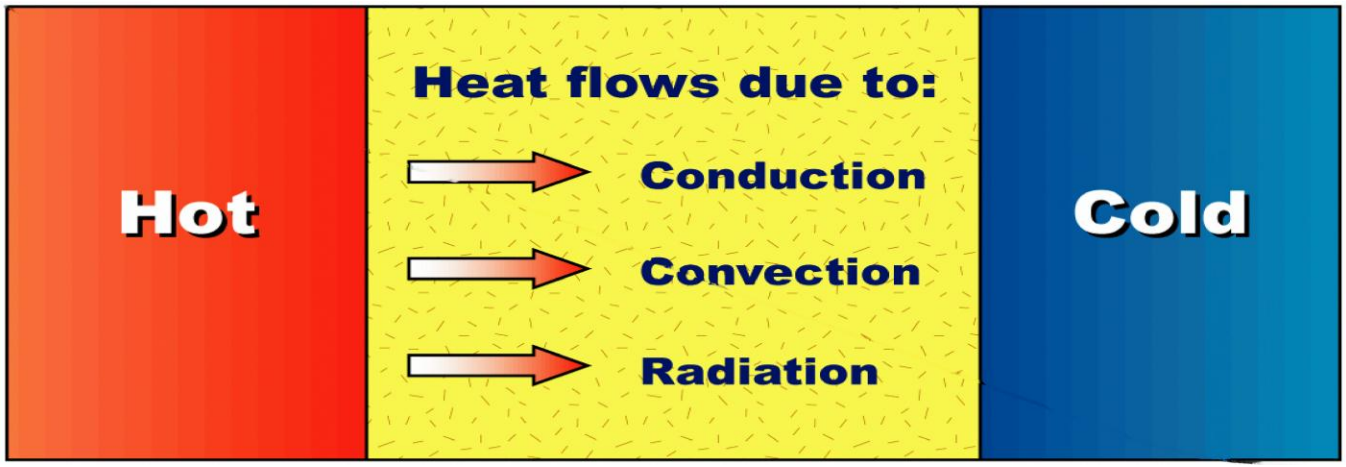
- When and where will the Earth receive the most sun energy?

The most sun energy will be transferred:

- at noon
- in summer
- on a clear day
- on a mountaintop
- in the desert
- to south-facing objects in the Northern Hemisphere
- or to north-facing objects in the Southern Hemisphere

Some Basics About Heat

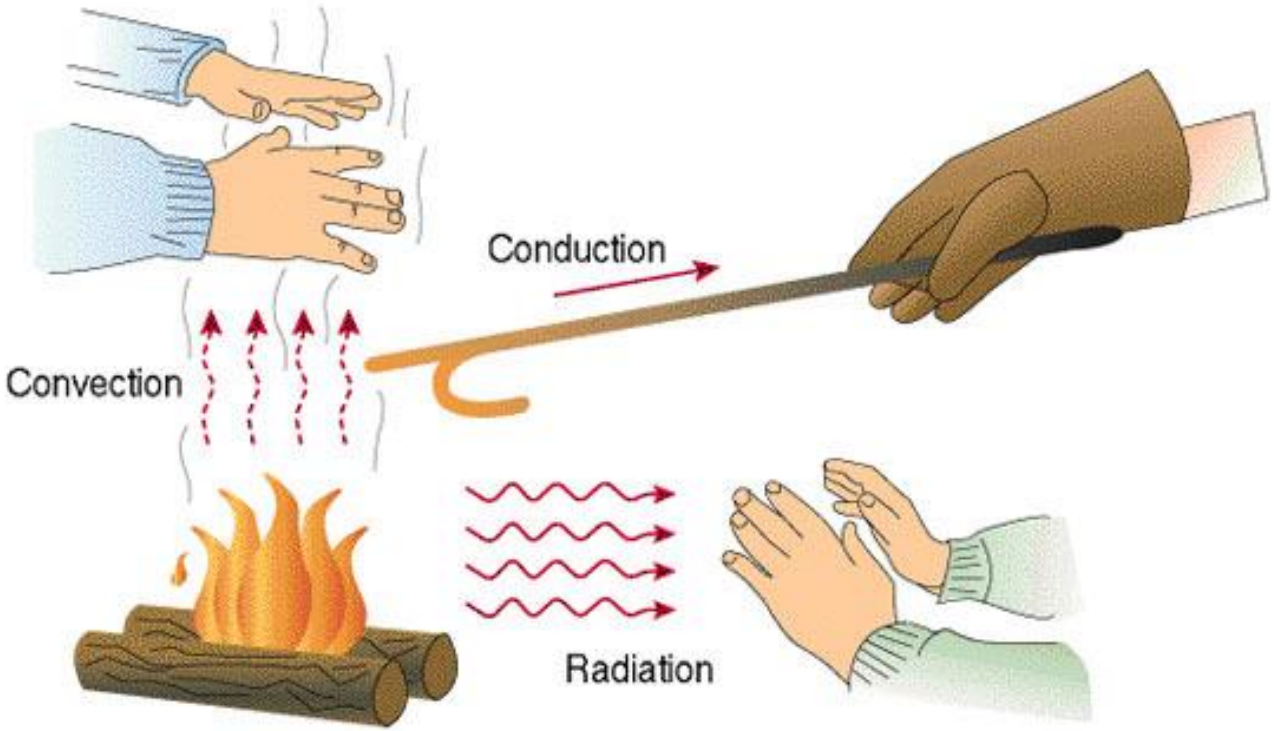
- Heat is energy transferred from one place to another.
- Heat flows spontaneously from the warmer place to the cooler place.
- The greater the temperature difference the faster the flow will be.



http://uselessenergy.net/insulation.htm

There are three ways heat transfers from place to place.

- Conduction
- Convection
- Radiation



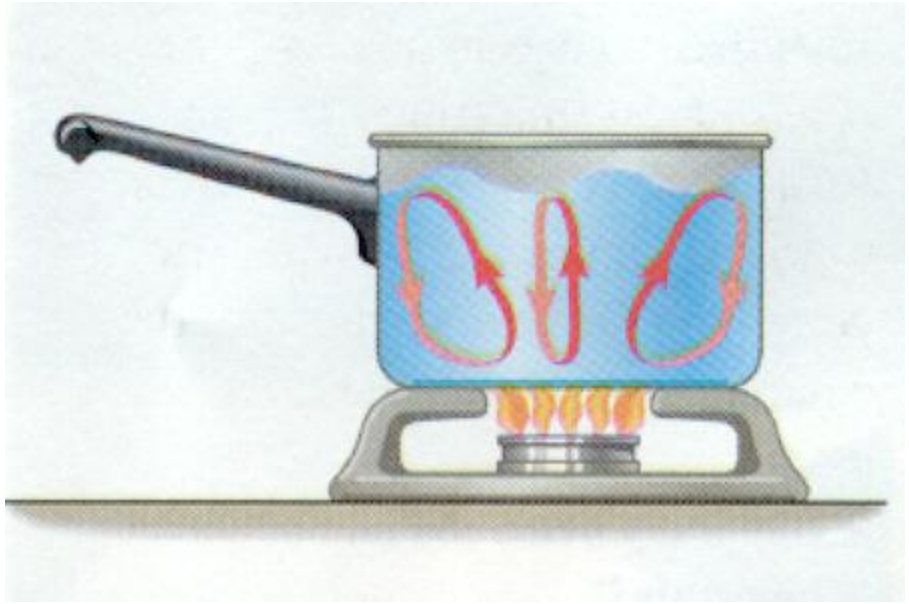
http://sustainability.williams.edu/

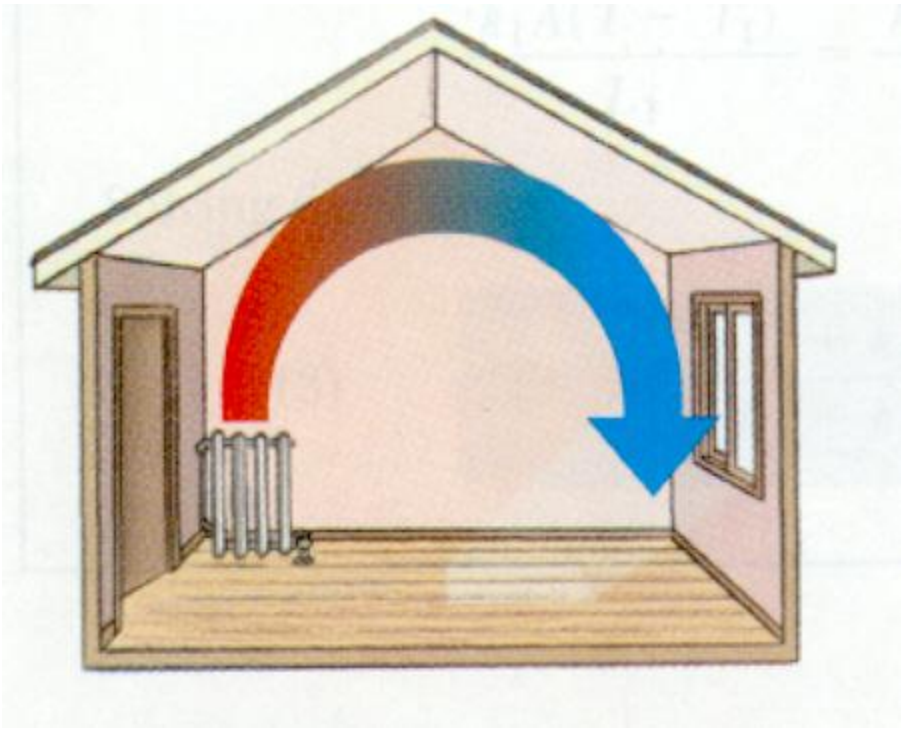
Conduction

Objects must be touching for heat to transfer.

Convection

Liquid or gas must move to transfer heat.



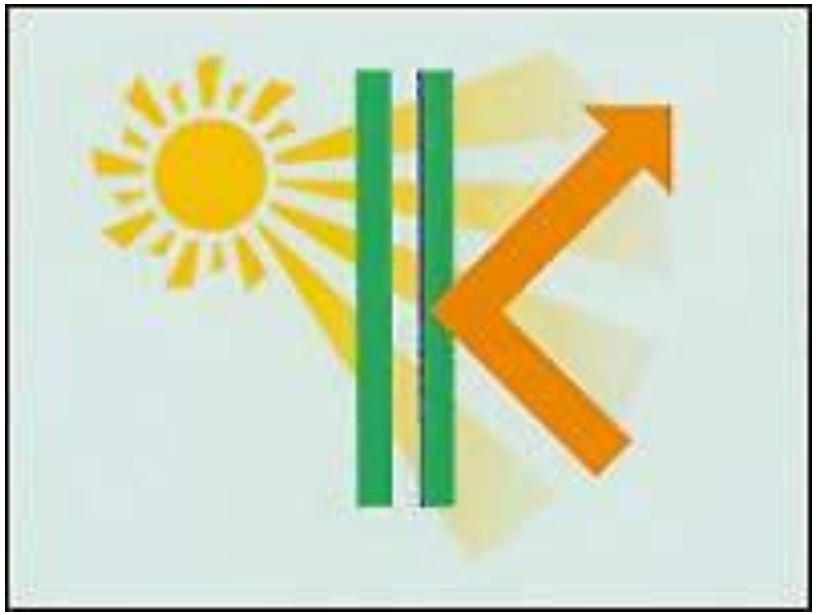


Hot liquids or gases rise, then cool, and fall.

http://www.physics.arizona.edu/~thews/reu/the_science_behind_it_all.html

Radiation

Heat transfers from one surface to a distant surface.

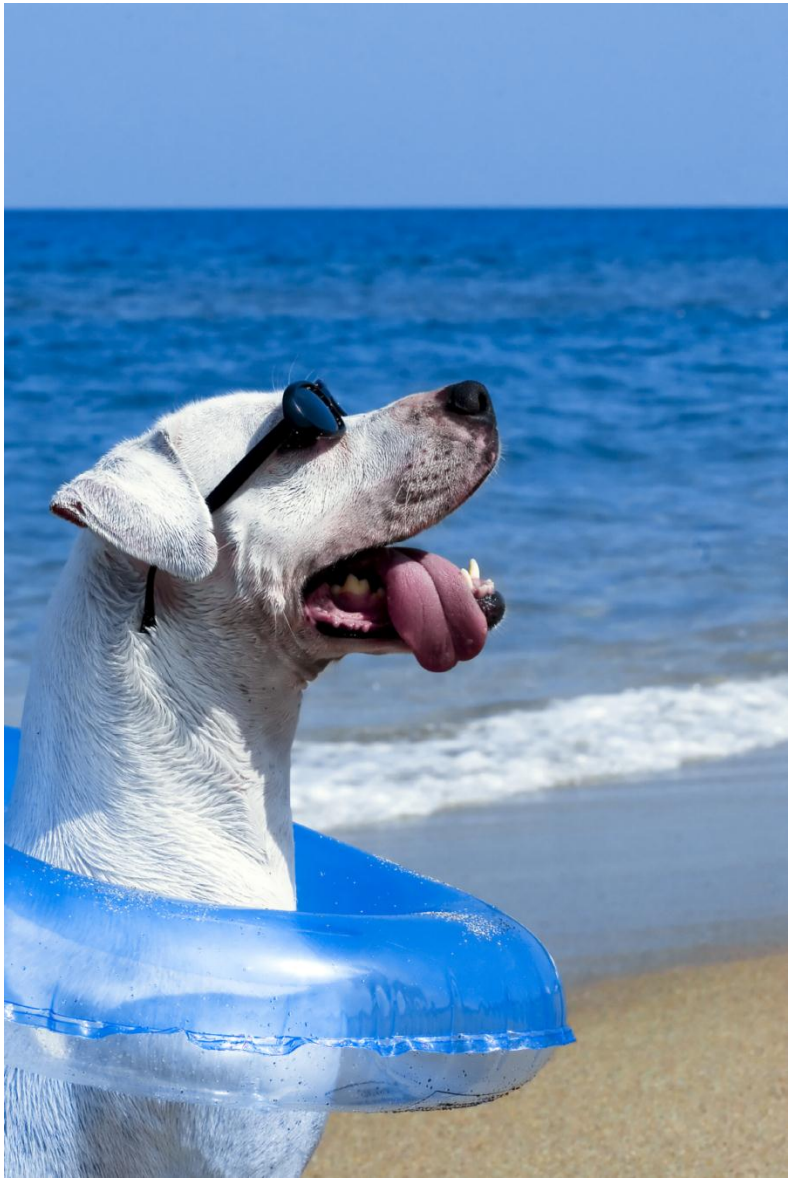


Heat energy from the sun radiates through a double paned window and is reflected back into the room

http://www.windowinfo.co.uk/upvc-windows.asp

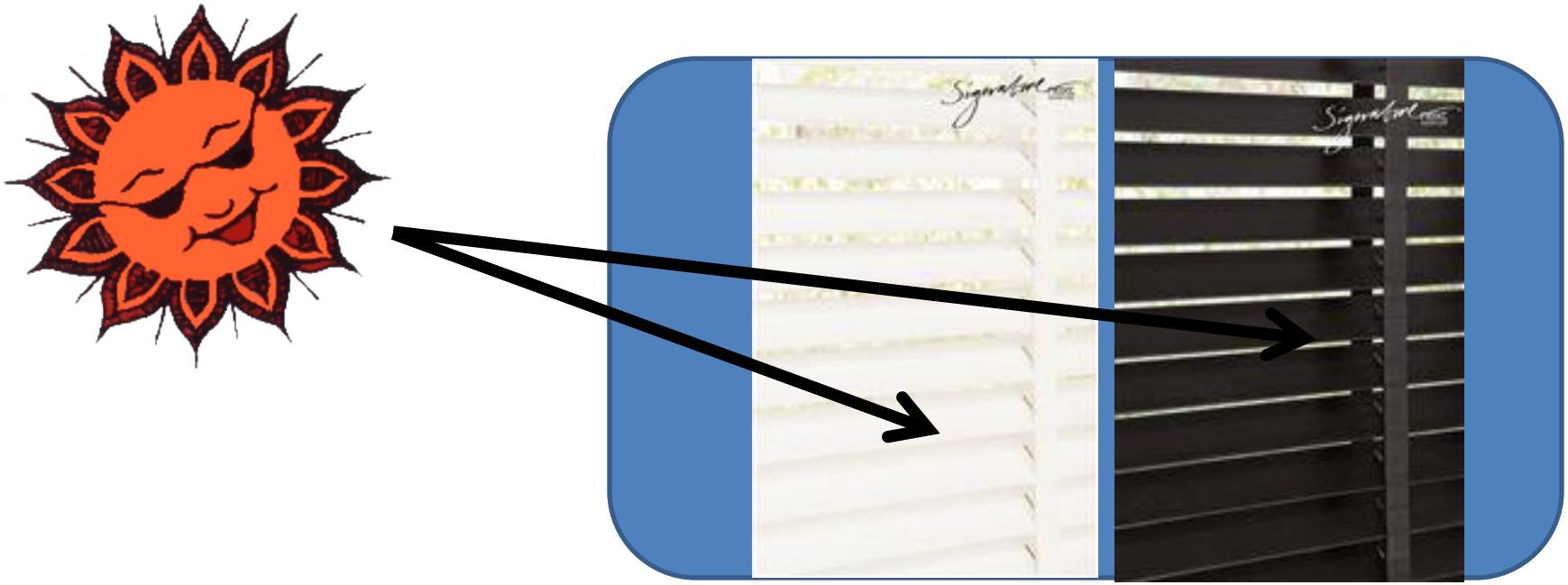
Question

- Can you describe how the three types of heat transfer occur in this picture?



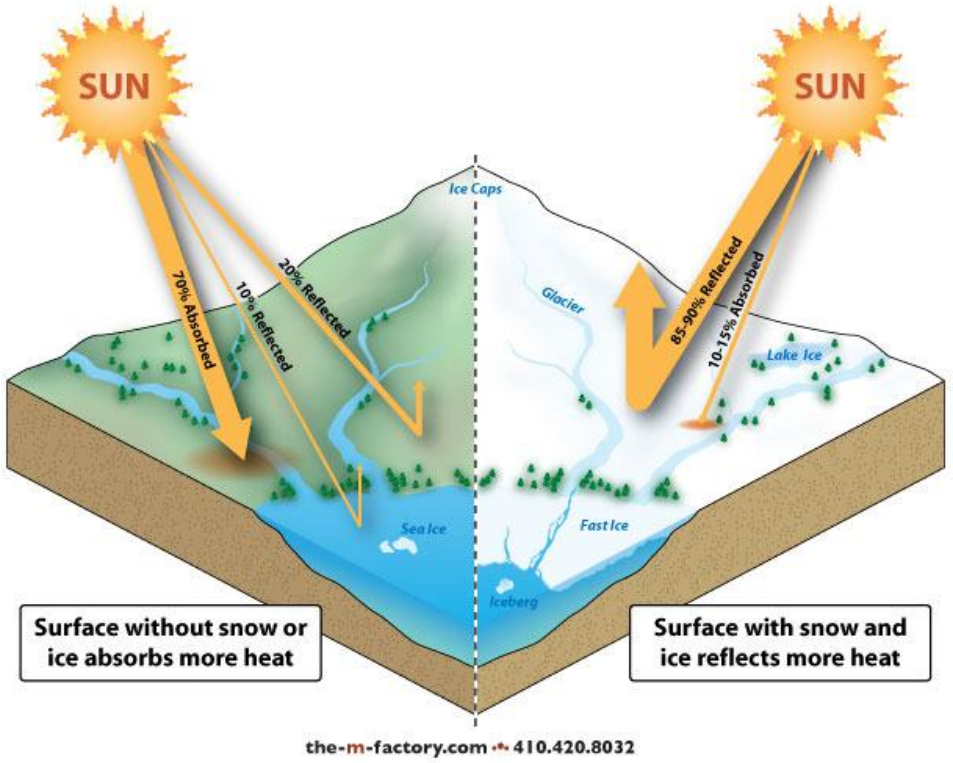
Heat Absorption

- As solar energy is absorbed at the surface of a material it stimulates movement of the molecules in the material.
- Molecular movement is measured in terms of heat energy – the greater the movement, the greater the temperature.
- Since the color black absorbs more radiation than the color white, it will be hotter (more molecular excitement).



Albedo

- The amount of sun energy that is reflected back by a surface
- Light colored surfaces have a high albedo, while dark colored surfaces have a lower albedo.



http://eo.ucar.edu/kids/green/warming3.htm

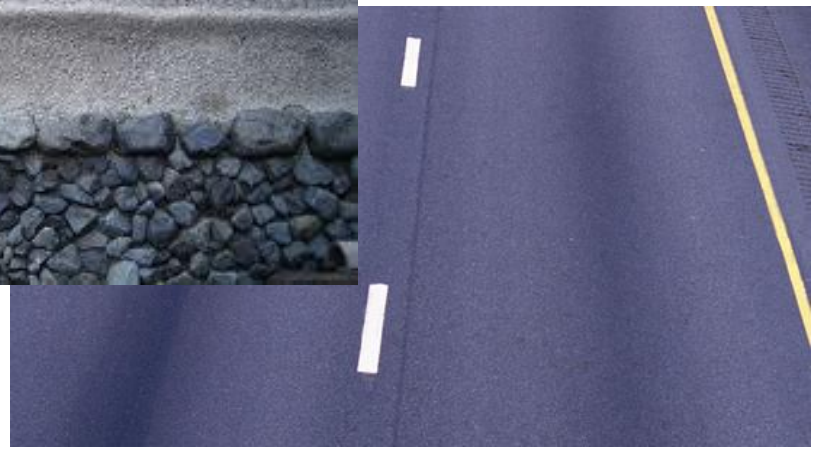
http://www.sciencebuzz.org/buzz-tags/albedo

Question

Which house will be cooler based on albedo? Why?

Heat Storage

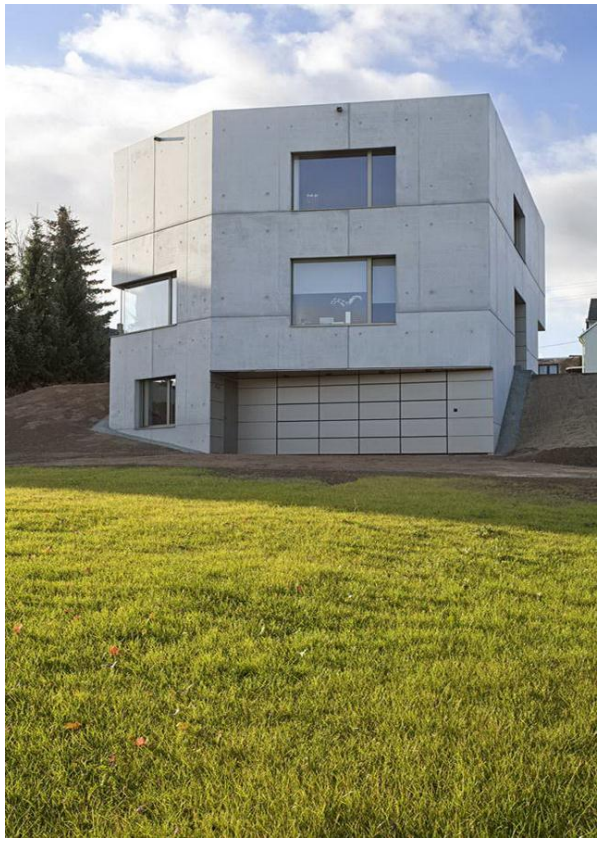
- The ability of a material to store heat is called its heat capacity.
- Materials with high heat capacity absorb heat easily when it is available, and then release heat as the surrounding temperature cools.



http://www.azsolarcenter.org/

Question

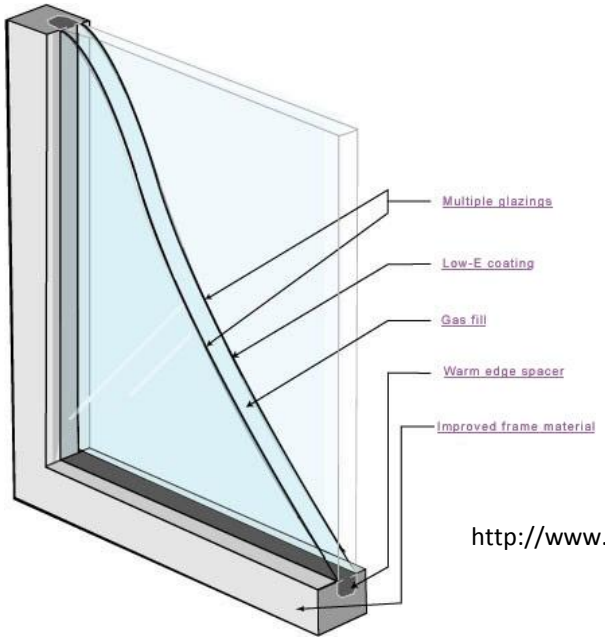
Which house would be cooler based on heat capacity? Why?



http://www.iroonie.com/

What can you do about heat flow at home?

- Conduction can be slowed by insulation.
- Use insulating material such as fiberglass batting in the walls and attic and dead air spaces, as in double-paned windows.



http://www.uwsp.edu/cnr/gem/SustainableEnergy/double-pane%20window.jpg

http://energytrust.org/residential/incentives/weatherization/insulationselfinstall1

What can you do about heat flow at home?

- Convection can be stopped by plugging the leaks between building materials.
- Use caulking and weather stripping.

http://utahcleanenergy.org/energy_efficiency/home

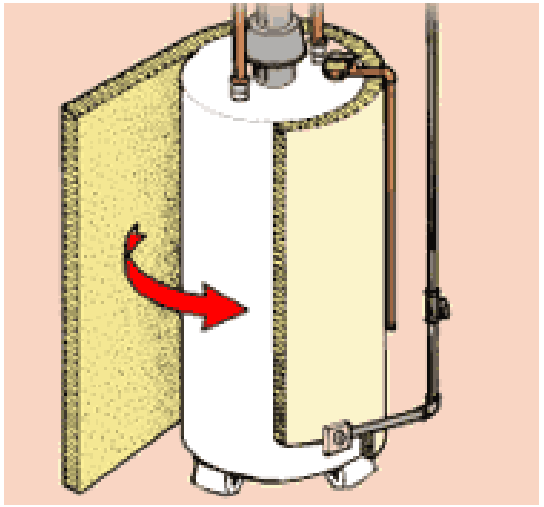
http://www.alleganyhrdc.org/weather.html

What can you do about heat flow at home?

- Radiation can be stopped by blocking or reflecting it.
- Use barriers such as awnings, window films, and a water heater jacket.

http://outdoorpatiocovers.net/

http://www.grist.org/



http://www.daviddarling.info/

What can you do about heat flow at home?

- Increase shade
- Increase your summer thermostat setting

http://reduce-your-carbon-footprint.net/

http://www.tranethermostat.org/

Heat Flow, Absorption and Storage affect living organisms too!

- One result of heat exposure to plants is desiccation and wilting.
- The leaves may loose too much water through evapotranspiration.

- Some plant species in hot environments have adapted over many generations to tolerate or avoid heat.
- The vertical position of leaves on this Sonoran Desert jojoba plant reduces exposure to the sun, so they absorb less heat.

Animals

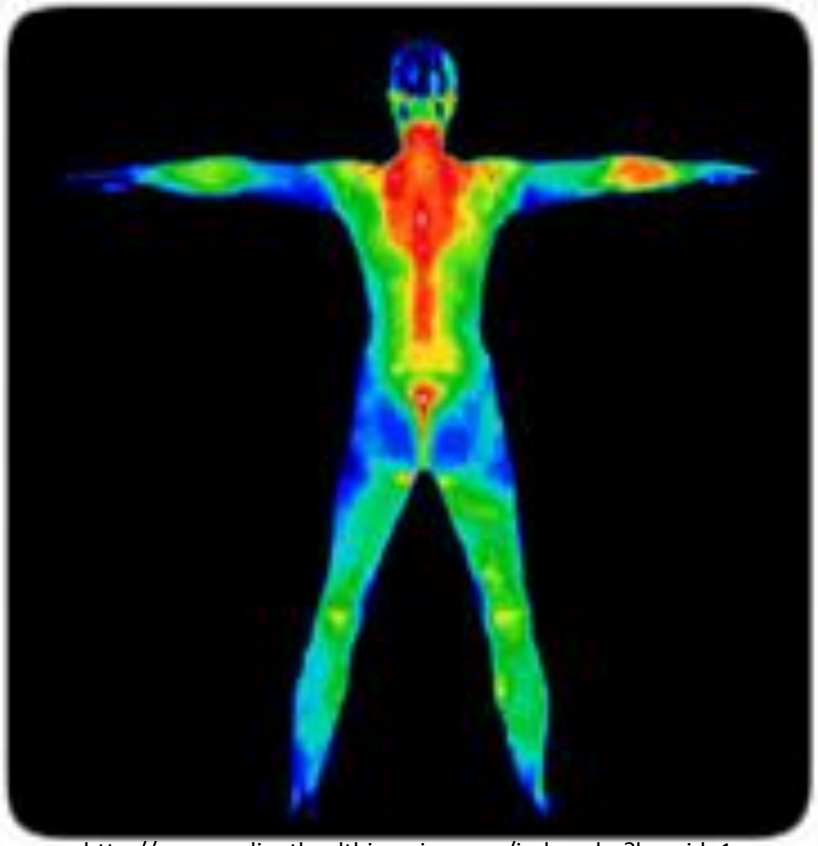
- The regulation of body temperature is called ***thermoregulation.***
- ***Endotherms***, like birds and mammals, maintain a constant body temperature, regardless of outside temperatures. They store a lot of heat from metabolizing their food.
- ***Ectotherms***, like many fish, reptiles and insects, have a body temperature that closely matches the outside water or air temperature. They don't need to eat as often.

A hummingbird pants to evaporate heat from its lungs and mouth.

A dark snake absorbs heat from the sun and the rock.

Question

Are humans endotherms or ectotherms?



http://www.radianthealthimaging.com/index.php?key_id=1

Endotherms! Energy from metabolizing our food helps keep us warm.

Question

How do humans avoid getting too hot?

- We can lower our activity level: we may feel sleepy or "lazy".
- We may blush (direct warm blood to the skin's surface, so it can radiate away).
- We sweat (direct water to the skin so it will evaporate and take the heat with it.)
- We can also take voluntary action (move to cooler temperatures in the shade, water, breezy area, or indoors).