

Engaging Students Through Interactive Activities In General Education Classes

*On the Cutting Edge: Early Career Geoscience Faculty Workshop
14-18 June 2009*

Presented by

Randy Richardson

*Department of Geosciences,
University of Arizona*

Elizabeth Ritchie

*Department of Atmospheric Sciences,
University of Arizona*

Katryn Wiese

City College of San Francisco



I. Introduction: Who is our audience?

What does “Interactive Lecture” mean?

II. Examples:

“Heat Transfer”

“ $F=ma$ ”

“Stripes on the Seafloor”

III. Singly, brainstorm ideas for your own class(es).

IV. With a partner, share your ideas and get feedback on what might or might not work in your setting.



Who is our audience in a General Education class?

Introductory-level courses bring a diverse group of students:

Recent High School Graduates

Workforce Graduates
(postponed college)

Professionals looking
for career changes



Remember: your setting matters. Know your environment.

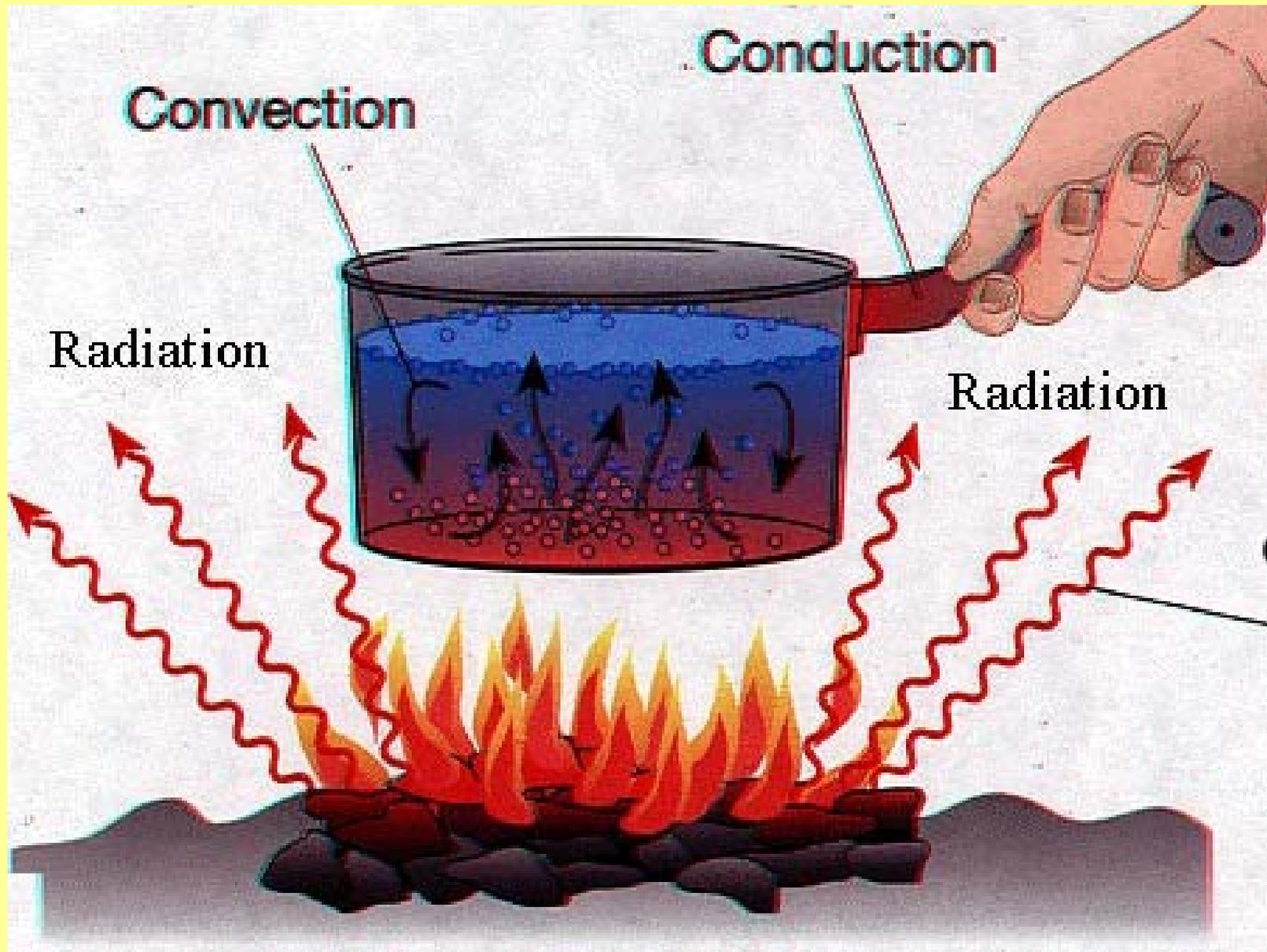
What does “Interactive Lecture” mean?

- Think/Pair/Share
- Discussion versus lecture
- Concept Tests
- Question of the day
- 2 Minute essay
- Jigsaw activities
- Group activities
- Individual activities
- Other



<http://serc.carleton.edu/introgeo/interactive/index.html>

HEAT TRANSFER ACTIVITY

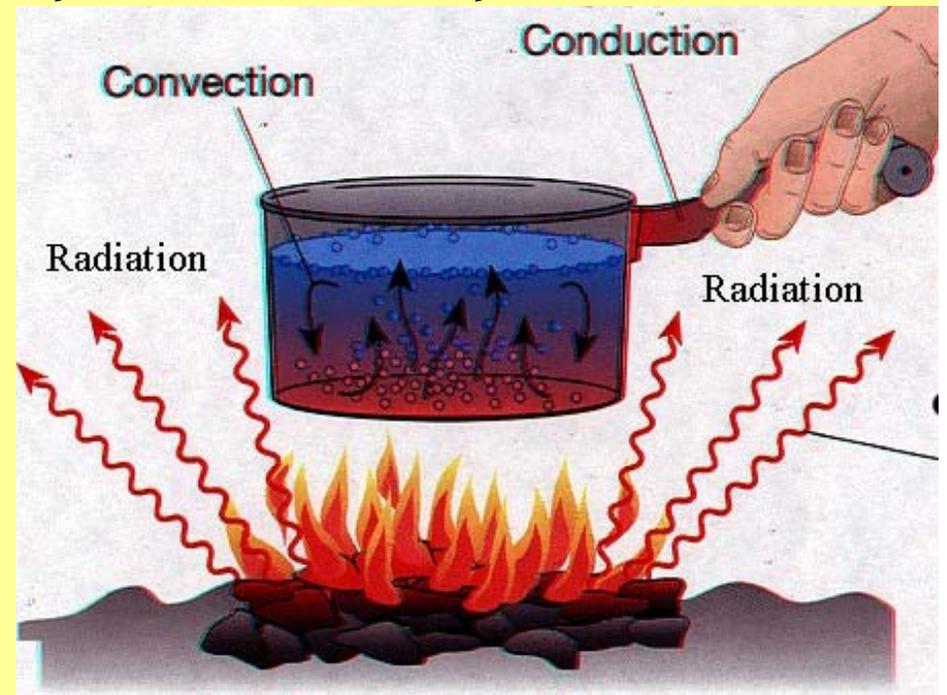


HEAT TRANSFER REVIEW

Heat can be transferred between atoms in contact with each by CONDUCTION. During conduction in a solid, molecules transfer vibrational energy physically to their bonded neighbors. In a liquid or gas, heat is conducted during collisions, when kinetic energy is transferred. Heat is transferred from high temperature to low temperature.

Heat can be transferred in fluids by CONVECTION. During convection, molecules of gas or liquid transport heat through motion of the molecules driven by diffusion or currents. Heat is transferred from high temperature to low temperature.

Heat is radiated from all objects whose temperatures are above 0°K . During RADIATION, electromagnetic waves (or photon particles) are released from the source and spread outwards through space in all directions. Thermal radiation is generated when heat from the movement of charged particles within atoms is converted to electromagnetic radiation.



GROUP ACTIVITY

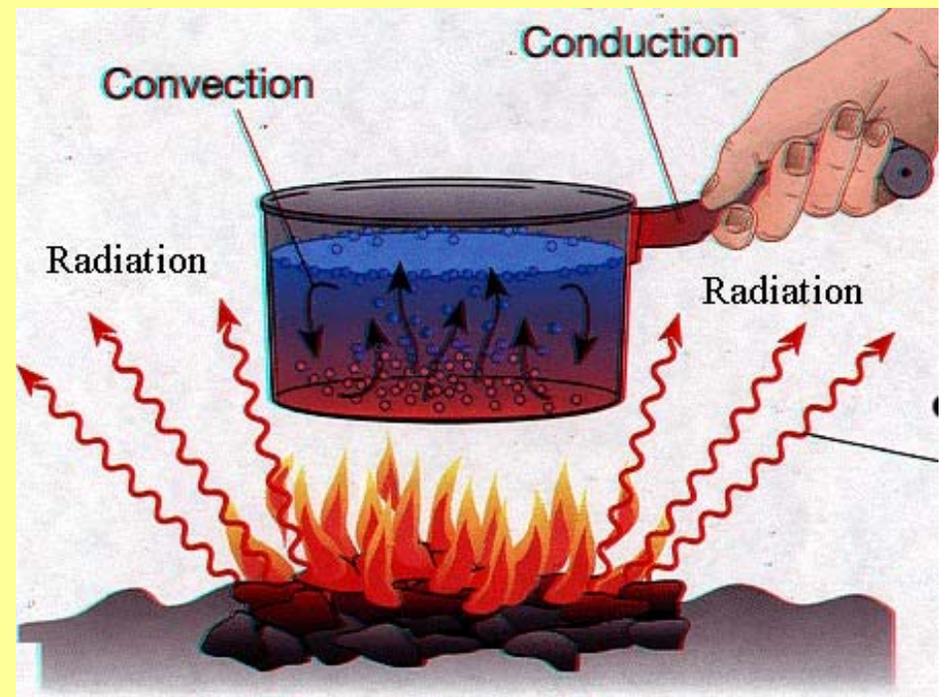
1. Everyone come to the front of the room and pick up 3 pieces of paper.
2. Move out to equally distribute yourself around the room.
3. Wad up each piece of paper into a ball.

The pieces of paper are units of heat.

You are each molecules of matter, in this case a gas or liquid and free to move about.

What type of heat transfer did we just demonstrate?

Has thermal equilibrium been reached? What does that mean?

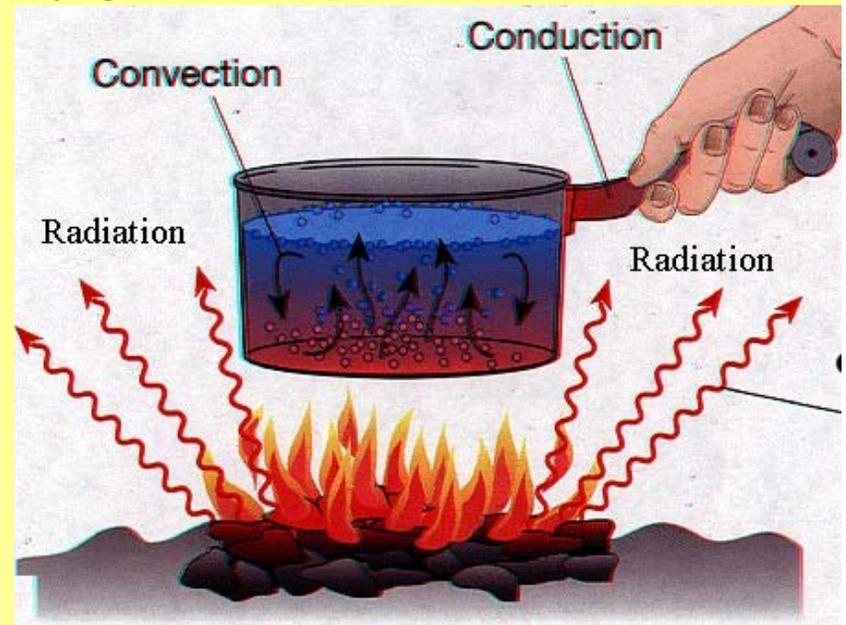


GROUP ACTIVITY

1. Everyone deposit your heat units in a pile in the center of the room.
2. Surround the pile in a large circle, standing shoulder to shoulder. *You are each molecules bonded in a solid that surrounds a large heat source.*
3. The person closest to the heat source should pick up the heat units and distribute them outwards around the circle.
4. Each person should pass the heat units they get to the person on their other side following the rules below:

- You can pass heat ONLY to people who have fewer heat units than you have.
- You can pass heat ONLY to people you are touching.
- Keep distributing the heat until thermal equilibrium is reached within the solid.

What type of heat transfer did we just demonstrate?

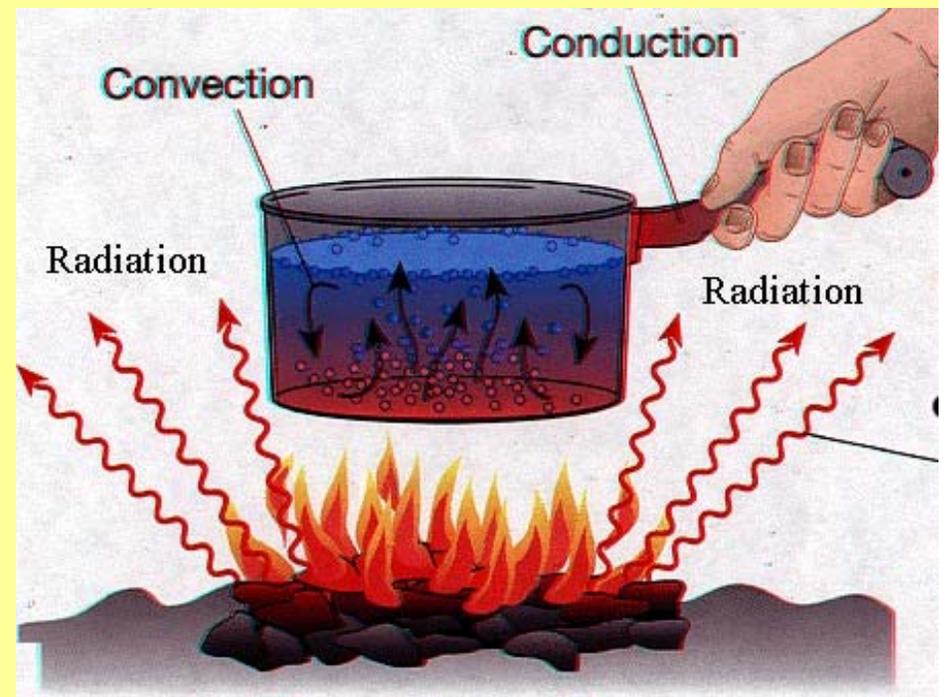


GROUP ACTIVITY

1. Imagine there is an invisible line separating the left and right halves of the room and going through the center of your circle. Separate from each other and spread out on your side of the room. No one from either half can move to the other side.
2. Everyone in the left half of the room throw your paper balls across to the right half (everyone on the right half catch or pick them up).

What type of heat transfer did we just demonstrate?

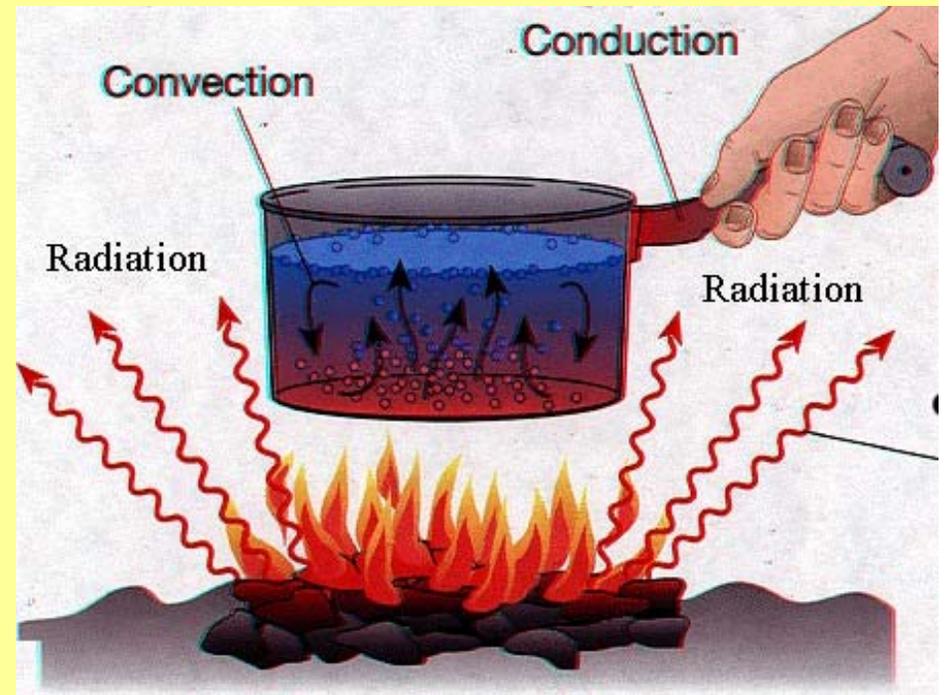
Do we have thermal equilibrium?



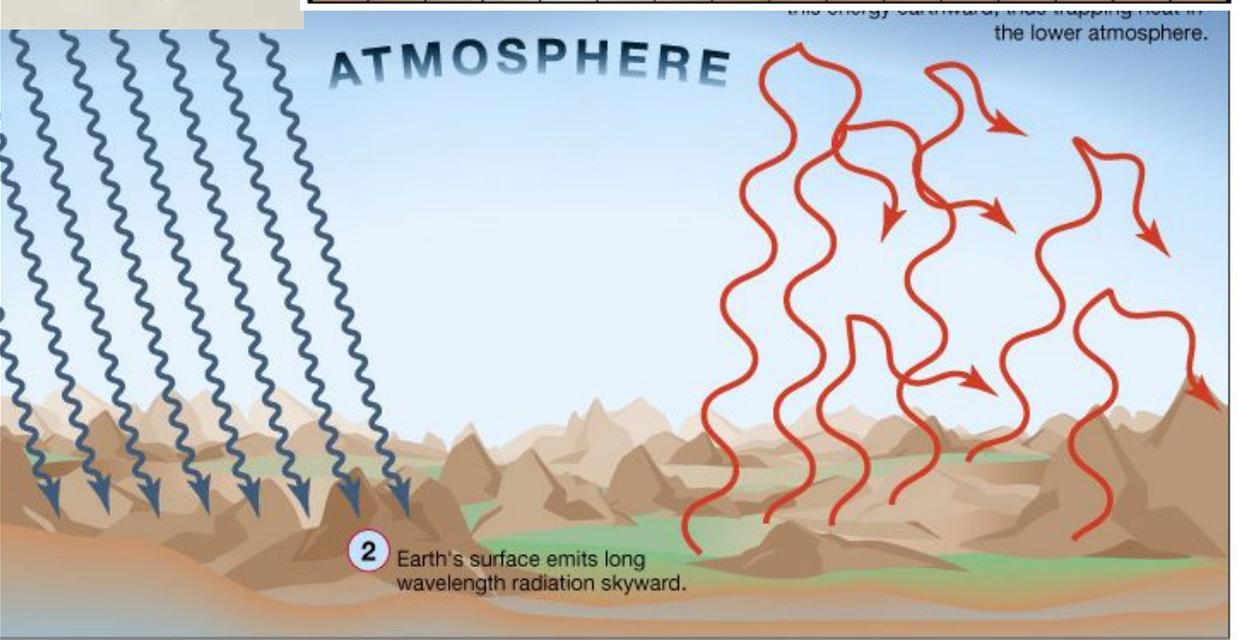
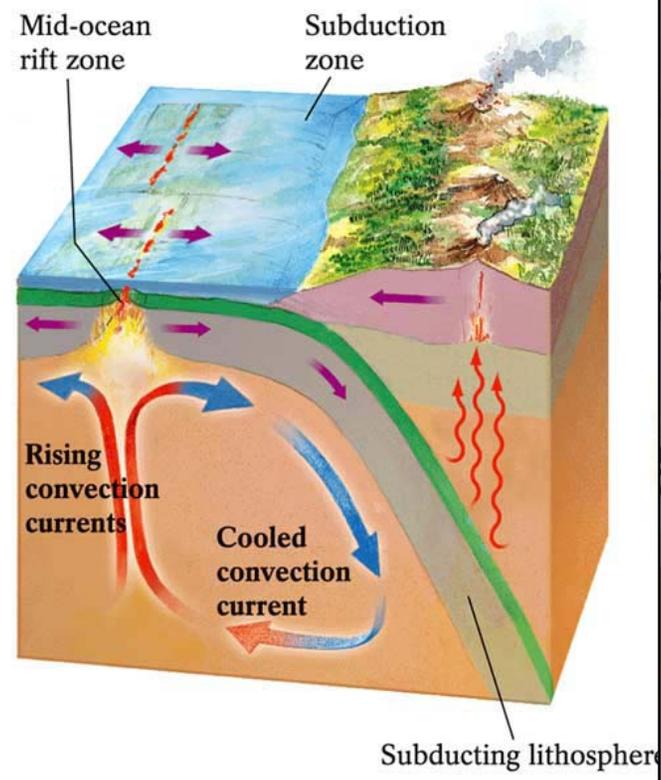
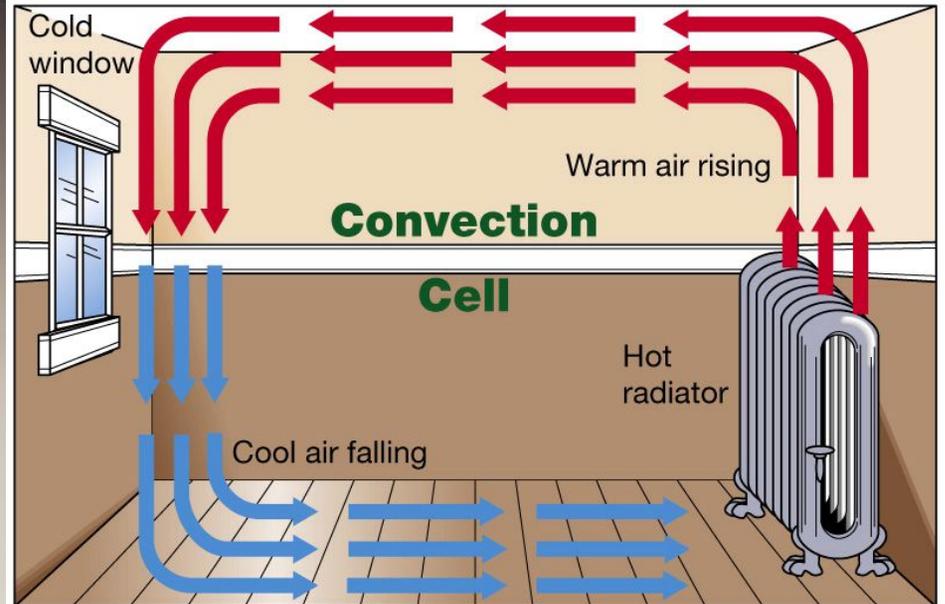
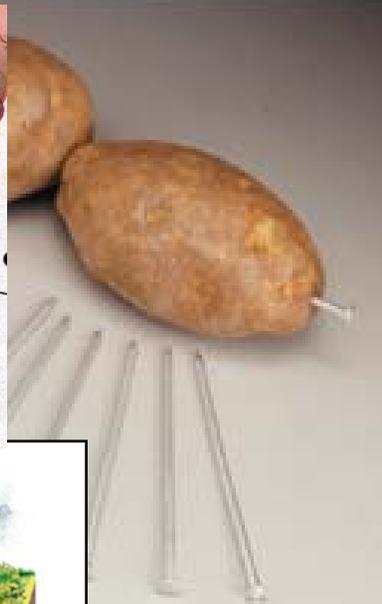
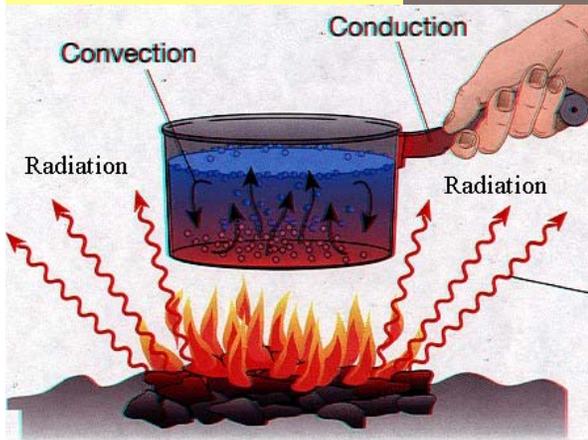
GROUP ACTIVITY

There are no more invisible lines. You have the entire room to spread out in. Use a combination of convection, conduction, and radiation to once again reach thermal equilibrium in the room.

MAKE SURE ALL HEAT IS ACCOUNTED FOR!



HOW DO THESE DEMONSTRATIONS RELATE TO REALITY? WHERE DO WE SEE HEAT TRANSFER OF EACH TYPE HAPPENING TODAY?



Wind:- is molecules of air in motion

- In order for air molecules to move they must be accelerated.
- An acceleration is either a change in speed or direction of an object (or both)



- Newton's 2nd Law: $F = m * a$ states that in order for an object to accelerate, it must have a force applied to it. The force is equal to the mass times the acceleration.

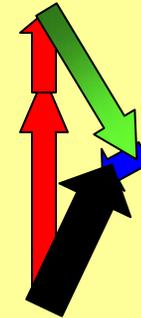
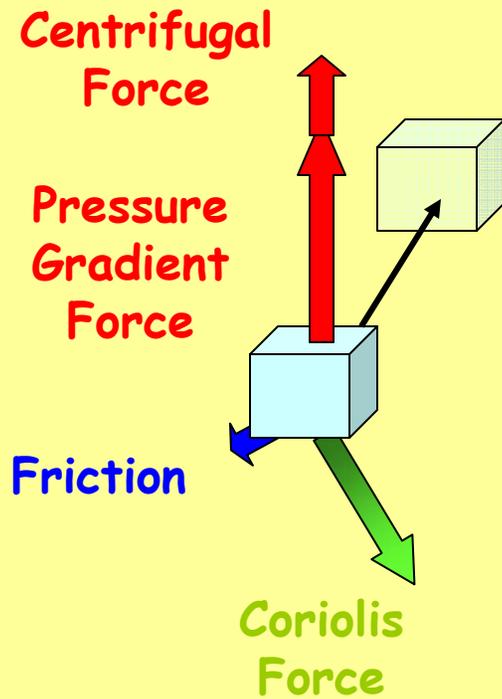
- Air molecules move, speed up or slow down because they have a net *force* acting on them, which produces a net *acceleration*.

- the four main forces that act on air are:-

- pressure gradient force
- coriolis force
- centrifugal (centripetal) force

- friction





- Net force = acceleration of air parcels and wind!



In-class Activity

-this may be done best by having only 10 or so people get up from their chairs.

Activity 1: stand in pairs holding hands. Lift one leg each off the ground and balance off each other. What is the net acceleration of each person? What is the net force acting on each person?

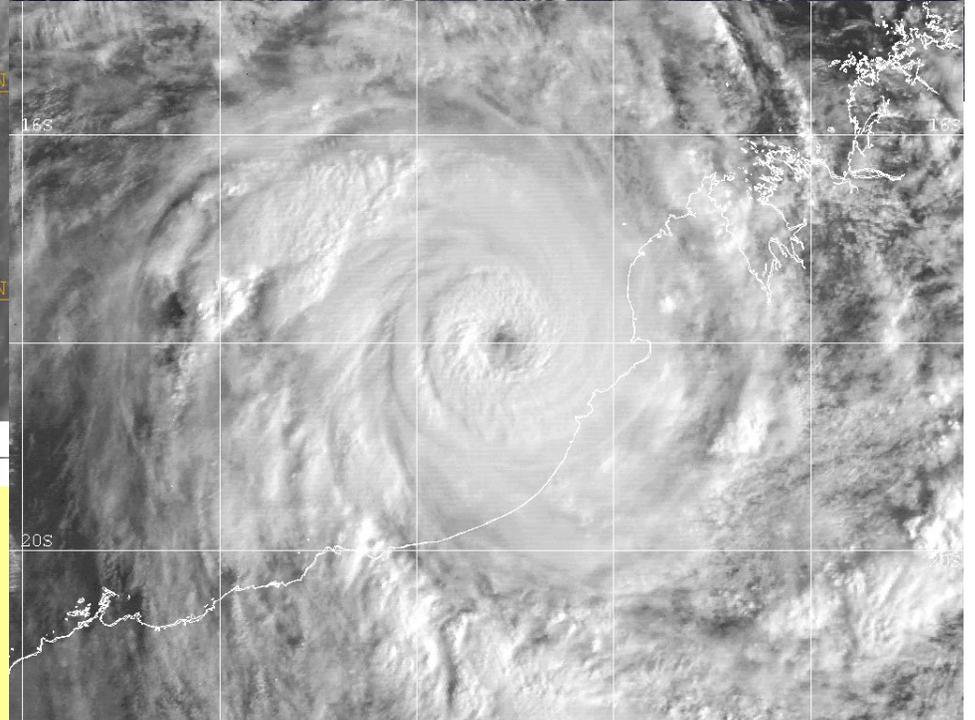
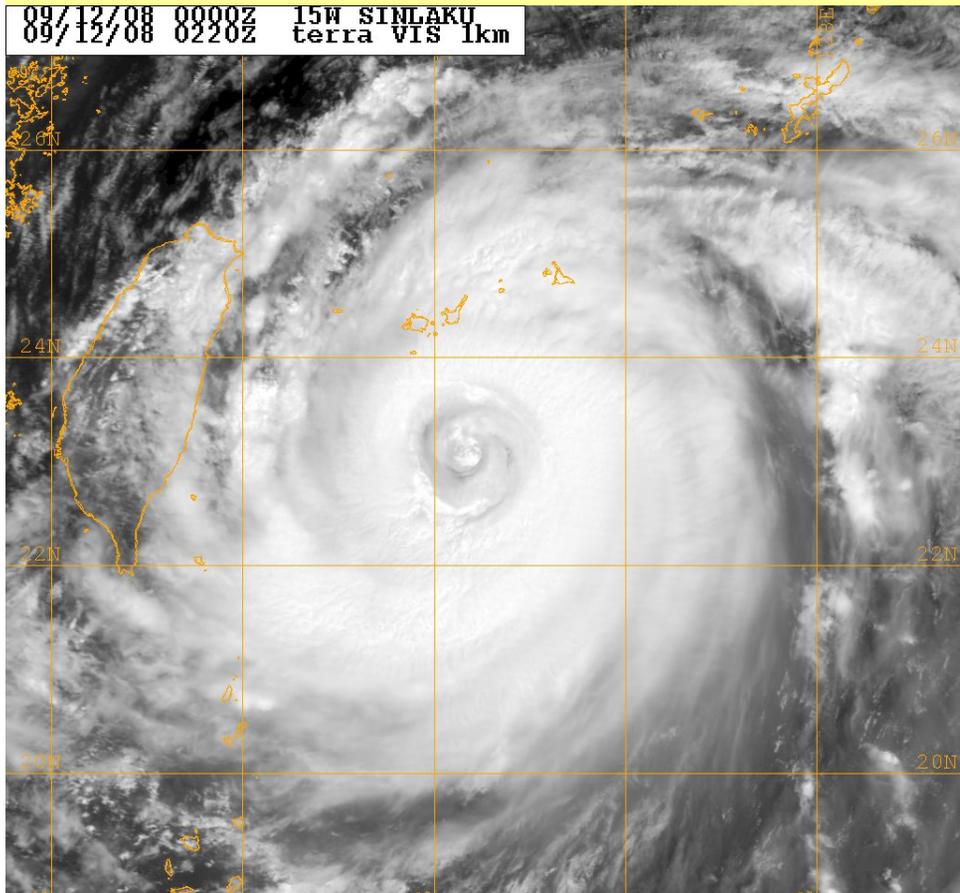
Activity 2: the person on the left now pushes the person on the right. What happens? In what direction was the net force?

Activity 3: have everyone take a pencil and roll it along the floor. In what direction was the initial force applied to the pencil? What happens to the pencil? Why? What other force was acting?

Activity 4: take two tennis balls (ping pong balls, pieces of balled up paper) and have people in pairs about 10 feet apart attempt to hit each other's ball. In what direction do the balls go? What is the direction of the net force?

Implications for Wind

09/12/08 0000Z 15W SINLAKU
09/12/08 0220Z terra VIS 1km



Naval Research Laboratory http://www.nrlmry.navy.mil/sat_products.html
<-- Visible (Sun elevation at center is 63 degrees) -->

Stripes on the Seafloor:

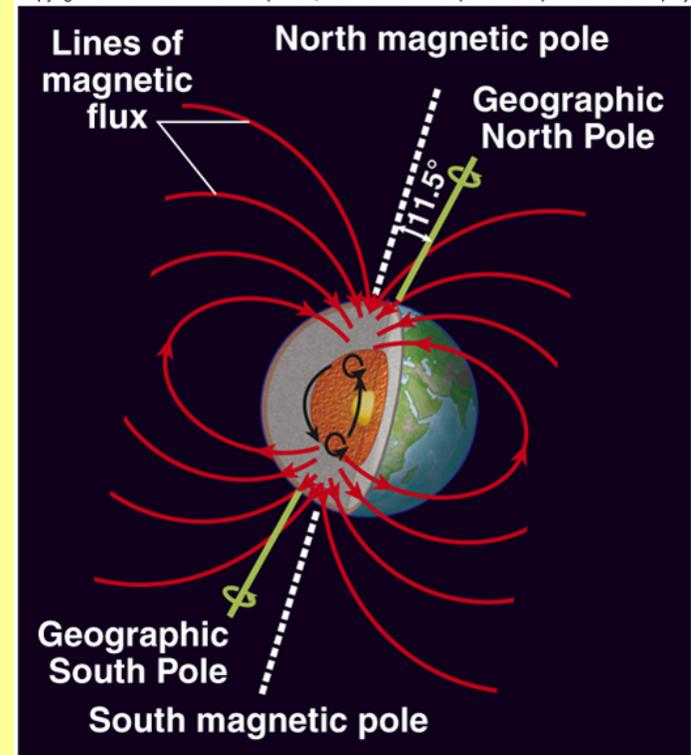
A Traditional Approach

Additional observations about the magnetic properties of seafloor rocks supported the seafloor spreading hypothesis

Earth has a magnetic field because it has:

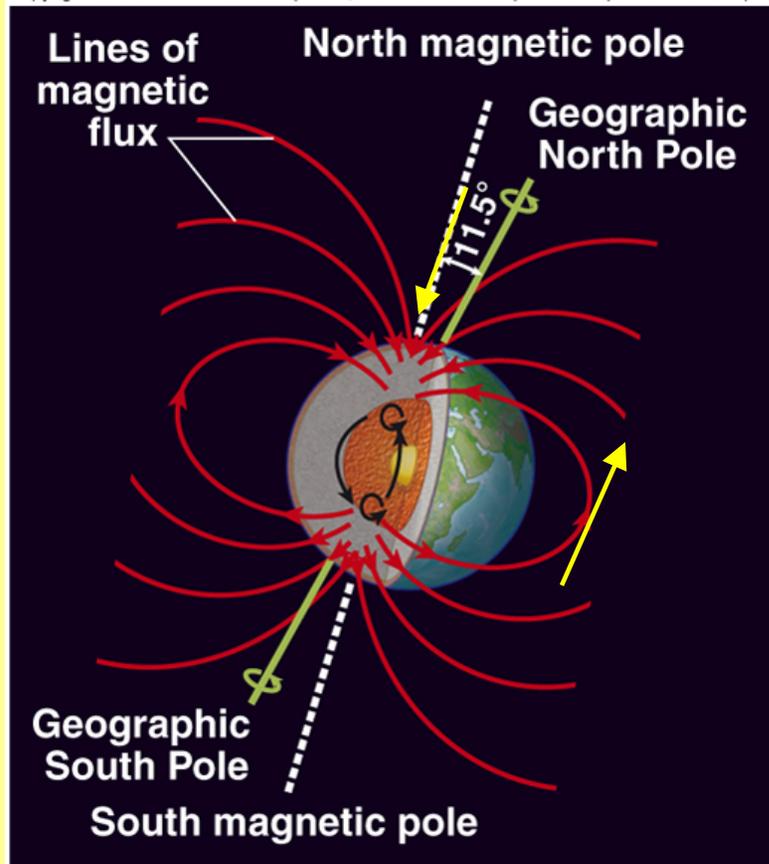
1. Molten rock in the outer core
2. Heat to generate currents in outer core
3. Rotation to mix the currents

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



Evidence from the Seafloor

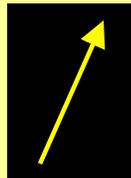
Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



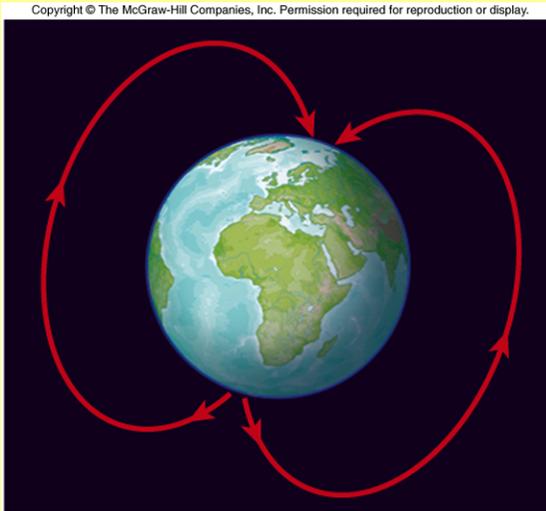
- Atoms in magnetic minerals aligned parallel to the magnetic field when magma cooled to form seafloor rocks
 - Preserves ancient magnetic field – **paleomagnetism**
 - Analysis reveals the inclination of the field where they formed – a proxy for latitude

Inclination: parallel to flux lines:

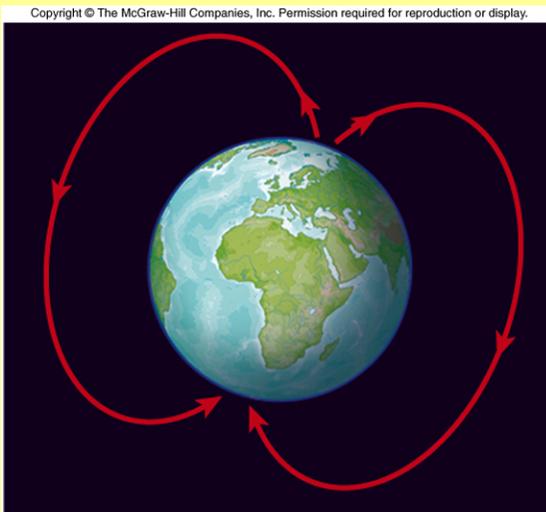
- Horizontal at equator
- Vertical at pole



Magnetic Field Reversals



a. Normal polarity



b. Reversed polarity

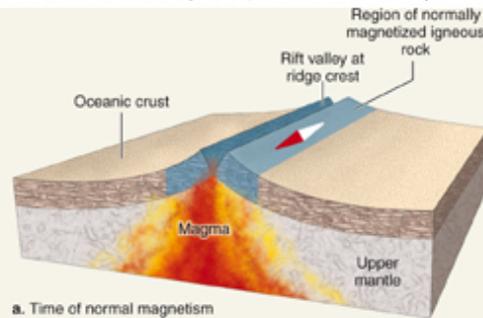
- **Normal polarity** when negative magnetic pole is near geographic North Pole (current status)

- **Reverse polarity** when positive magnetic pole is near geographic North Pole

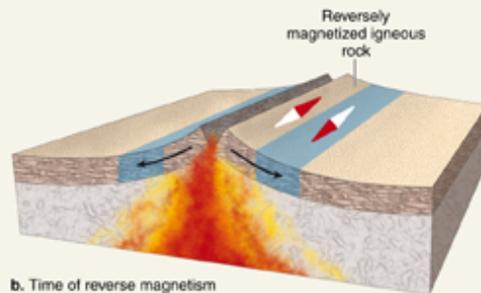
- Each period of normal or reversed polarity averages 250,000 years
- Longest = 10's of millions of years
- Shortest = 10's of thousands of years
- Few thousand years to change polarity (normal → reverse or reverse → normal)

Evidence from the Seafloor

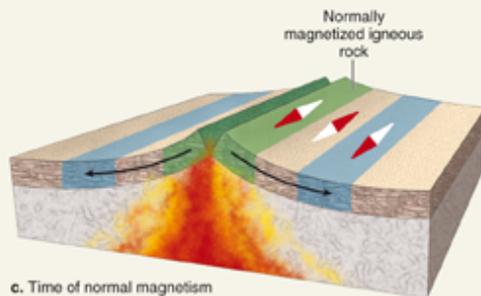
Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



a. Time of normal magnetism



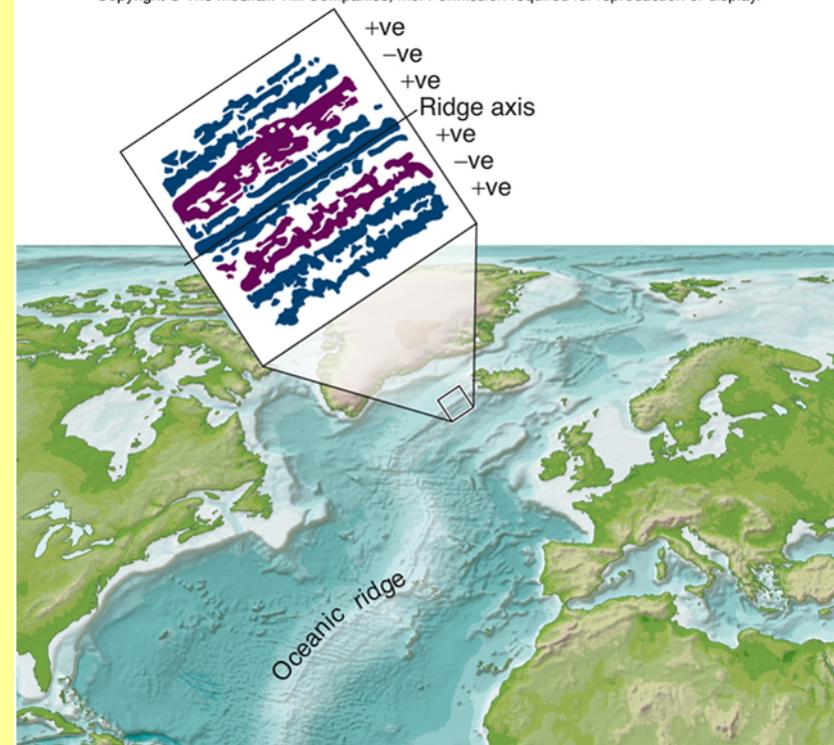
b. Time of reverse magnetism



c. Time of normal magnetism

Polarity of seafloor alternates between normal (+) and reverse (-) on either side of oceanic ridge

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



In-Class Activity

- Assemble ~20 students at front of room as a magma chamber beneath the continent.
- Two students at the top of the magma chamber represent continental crust above a future mid-ocean ridge.
- The continent rifts apart: these two students each take one step sideways, allowing out two new students (oceanic crust).
- The new ones out face forwards because they formed when the Earth's magnetic field is in its normal polarity.
- Now all four students outside the magma chamber again take a step sideways letting two new students out.
- All six students take a step sideways and let two new students out. This time, however, I tell them that the Earth's magnetic field has reversed, and the two new students come out facing backwards.

In-Class Activity, continued ...

- I let the process continue, sometimes reversing the magnetic field, but in the end producing 'stripes' of students facing opposite directions representing crust that was created during normal and reversed polarity times.
- We continue until the students run into a wall or until I feel that they understand the process.
- An added benefit of this demonstration is that students can see why the oldest sea floor is next to the continents and farthest from the mid-ocean ridge (they were the first ones out).
- Finally, it also leads naturally into a discussion of recycling of oceanic lithosphere when the students run into the wall at the edge of the classroom.

Plate Tectonics Conceptest

#6 – The youngest seafloor is found (1pt)

- A. at the edges of the continents
- B. at places where seafloor is returned to the mantle (subduction zones)
- C. in the abyssal plain (flat part away from ridges and continents) portion of the seafloor
- D. at mid-ocean ridges

ON YOUR OWN

YOU HAVE ~5 MINUTES TO WORK ON THIS:

Think about and design a short, 5-minute interactive demonstration or activity for one of your courses on one topic.



WITH A PARTNER

**YOU HAVE ~10 MINUTES TO WORK ON THIS
(each person gets 5 minutes):**

**Discuss your activity with your partner – try it out
– ask questions – elicit feedback.**





FINALLY

The literature is clear: students learn more when they are actively engaged in their learning.

Look at some of the supporting materials we have provided and visit

<http://serc.carleton.edu/introgeo/interactive/index.html>

(or <http://serc.carleton.edu/> in general)