# Lesson #2: Heat Transfer (6 class periods)

## Objectives

**Students will be able to…**

- Understand heat transfer in a building assembly.
- Identify ways to improve an assembly to limit heat transfer.
- Describe ways to maintain indoor comfort.

## Standards

LS 11-12.6
RSIT 11-12.2
RHSS 11-12.7
Problem Solving and Critical Thinking 5.1, 5.3, 5.4
Health and Safety 6.2, 6.3, 6.4, 6.5, 6.6
Mathematics 1.1
Communication 2.2
Responsibility and Flexibility 7.0
Leadership and Teamwork 9.0
Technical Knowledge and Skills 10.0, 10.1, 10.2, 10.3
Demonstration and Application 11.0
Residential and Commercial Pathway D1.2, D1.3, D1.4, D1.5, D2.1, D2.2, D3.1, D3.2, D3.3, D 9.1, D 9.2, D9.3, D9.4, D9.5, D9.6

## Materials

Building Science Introduction: Heat Flow, Moisture Flow, Air Flow
Law of Thermodynamics Handout
Modes of Heat Transfer Handouts
Thermal Energy Transfer via Conduction Activity
YouTube Video Recommendation List
Building Materials: insulation, framing, glazing, radiant barrier - anything readily available
Thermometers-probe, infrared, indoor/outdoor, thermal imaging
Heating and air movement devices-heating pad, heat lamp, hot plate, blow dryer fan

## Lesson Sequence

- Pass out and review the ***Building Science Introduction: Heat Flow, Moisture Flow, Air Flow handout.*** Be sure to address the vocabulary words R-value, U-factor, air infiltration, relative humidity. Have students highlight important information.
- Review the ***Law of Thermodynamics Handout.*** First law-energy cannot be created or destroyed; it can only change from one form to another. Second law- heat always flows from a hot body to a cold one when there is no outside influence.
- Review the ***Modes of Heat Transfer Handout.*** Discuss the difference between conduction, convection, radiation.
- Watch a YouTube video from the ***Recommended YouTube Video List.***
- Identify modes of heat transfer in the room/building based on outdoor conditions (example-summer vs. winter)
- Perform R-value to U-factor conversion and discuss when this is applicable and important
- Determine the rate of heat transfer through multiple building materials/assemblies. Which one performs better in limiting heat? (example-fiberglass batt alone, fiberglass batt with air/vapor barrier, rigid insulation, framing members, any sort of metal, liquid, or available building material. Heat one side and measure temperature difference on the other. Blow hot air vs. static heat (from heating pad or heat lamp) to see if any difference.
- Review the ***Thermal Energy Transfer via Conduction Activity*** and support students as they participate in the activity.

## Assessment

Data gather in groups or individuals
Heat Transfer Quiz

## Accommodations/Modifications

Check for Understanding
One on One Support
Peer Support
Highlight Important Material Ahead of Time
Visuals

# YouTube Video Recommendation List

- Heat Transfer, Mike Sammartano- https://youtu.be/kNZi12OV9Xc
  - Has worksheet available

- A Home's Air Infiltration and Heat Transfer (Chapter 2), Iowa NSF EPSCoR- https://youtu.be/cec0T9Ihu2A
  - 5 minutes in length, covers vocabulary and high-level concepts of heat transfer

- Thermal Envelope: Air Leakage, MWAlliance- https://youtu.be/6oIAy_yqrGU
  - Steve Easley explains basics of air infiltration, including real world examples. The video is a little long but will touch on information used in other courses.
  - Important to note when Steve mentions "Code" he is NOT referring to California, he's referring to IECC.
  - The "science" portion ends at 03:06. There are a few general examples that follow and may be useful

# Heat Transfer Quiz

1. Which of the following must be present for air to travel in and out of buildings?
   a. A hole
   b. A difference in pressure
   c. Both a hole and a difference in pressure
   d. None of the above

2. Which of the following can cause uncontrolled airflow in a building?
   a. Wind effect
   b. Stack effect
   c. Mechanical effect
   d. All of the above

3. Which of the following best describes the term U-factor?
   a. The ability of a material to resist heat flow
   b. The rate heat flows through a material or assembly
   c. The amount of heat given off by one burning match
   d. The quantity of energy from the sun over a square meter

4. Which of the following best describes the term R-value?
   a. The ability of a material to resist heat flow
   b. The rate heat flows through a material or assembly
   c. The amount of heat given off by one burning match
   d. The quantity of energy from the sun over a square meter

5. Which of the following best describes the term BTU?
   a. The ability of a material to resist heat flow
   b. The rate heat flows through a material or assembly
   c. The amount of heat given off by one burning match
   d. The quantity of energy from the sun over a square meter

6. Which of the following variables are necessary for calculating the rate of heat loss (in BTUs per hour) through a section of the building envelope at any given temperature difference?
    a. The area of the building envelope
    b. The temperature difference between the inside and outside
    c. The combined R-values of the entire assembly
    d. All of the above

7. What type of heat transfer is occurring when heat is moving through a wood stud?
    a. Conduction
    b. Convection
    c. Radiation
    d. Infiltration

8. Insulation material is commonly rated according to which of the following?
    a. U-factor
    b. Pascals
    c. CFM
    d. R-value

9. The major cause of increased heat transfer through wall insulation is caused by which of the following?
    a. Gaps between the insulation and the air barrier
    b. Overly compressed insulation
    c. Misalignment between the insulation and air barrier
    d. All of the above

10. Which of the following effects best describes the ability of water to travel up against the pull of gravity through a porous material?
    a. Vapor Diffusion
    b. Capillary action
    c. Hydraulic pressure
    d. All of the above

## Heat Transfer Quiz – *Answer Key*

1. C
2. D
3. B
4. A
5. C
6. D
7. A
8. D
9. D
10. B