LESSON

Introduction to Principles of Energy

BIG IDEA(S)

Building Science is an approach to weatherization that uses modern technology to study building construction, maintenance, safety and durability in an effort to increase energy efficiency. In home auditing and consequent retrofit, technicians use their knowledge of the kinds and properties of energy to evaluate the properties of materials and the methods to achieve energy efficiency.

OBJECTIVES

Students will:

- Explain energy, its varieties, sources and behavior
- Explain the laws of thermodynamics and provide examples
- Explain examples of energy measurement including use of both Fahrenheit and Celsius scales
- Describe the use in weatherization of the British Thermal Unit (BTU)
- Apply energy concepts to materials and processes used in weatherization work

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TASK LIST SUBCATEGORY

101	Explain the principles and physics of energy
801	Identify the principles of building science
809	Apply math concepts to weatherization
810	Use energy efficiency vocabulary

OVERVIEW

Energy is covered in both the solar and weatherization fields. NOTE: Some of these topics may have already been presented in prior lessons where these principles are applied. This lesson can be either an initial presentation or a review if already studied. The energy topics most important to the work of a retrofit technician include energy conservation measurement, laws of thermodynamics, forms of energy, and the heat transfer process. It is best present these energy concepts as hands-on and concrete as possible for 10th grade students.

STANDARDS

PA/SDP

3.2.C.B3. Describe the law of conservation of energy.

3.2.P.B3. Describe the factors that influence **convection, conduction,** and **radiation** between objects or regions that are at different temperatures.

3.4.10.E3. Compare and contrast the major forms of energy: thermal, radiant, electrical, mechanical, chemical, nuclear and others.

CC.3.5.9-10.A. Reading: (Specific Anchor) Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

KEY TERMS

Energy: the ability to do work

Work: the transfer of energy

Temperature: the measurement of the vibration of molecules in a substance

Celsius: a temperature scale used everywhere except the U.S.

Fahrenheit: temperature scale used in the U.S.

British Thermal Unit (BTU): the quantity of heat required to raise the temp of one pound of pure water one degree F°

1st and 2nd Laws of Thermodynamics

Delta T: difference in temperature in two areas

Heat transfer process: conduction, convection and radiation

INSTRUCTIONAL

TEXT/REFERENCES

Energy Conservation Handbook. pp. 106 - 110

MATERIALS NEEDED

Teacher Presentation: Print out the quiz, if using; provide projection of graphics and videos for the whole group

MATERIALS

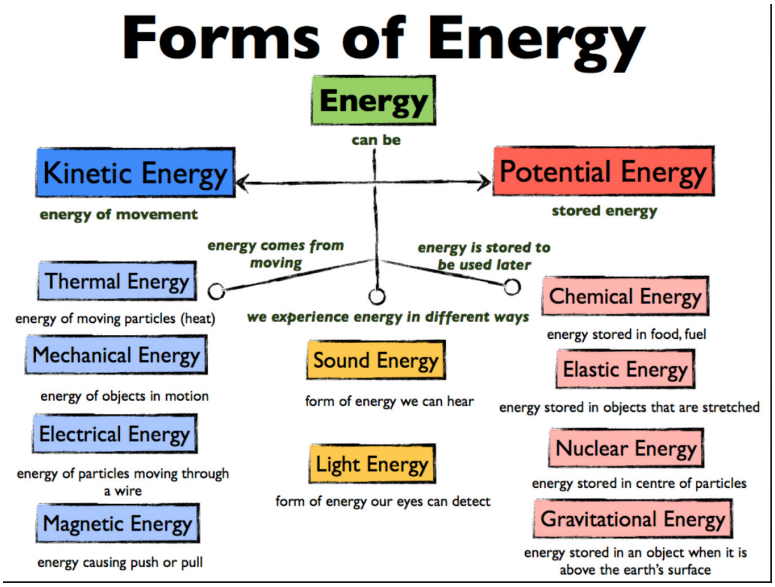
- Candle and matches to illustrate potential and kinetic energy; chemical, radiant, thermal energy
- Illuminated clear incandescent light bulbsprayer with water

Technology: Share videos and visuals in the lesson with the class

IMPLEMENTATION (LESSON PLAN)

ENGAGE

1. Use a candle and match to illustrate potential and kinetic energy, and bring in chemical (candle), radiant (light) and thermal (heat emission using a blown up balloon moving it closer to the flame to let it pop).
2. *There are two kinds of energy, potential and kinetic.* Provide a brief example of each. Have students identify what in the demo had potential and kinetic energy. Ask for a definition of each. Discuss the properties of the candle, light and heat, assessing student background knowledge. Use the chart to present the major kinds. You can build your own chart for students as you explore the main types of energy that can remain in the classroom for reference.



EXPLORE

1. Energy is the ability to do work. There are two main categories of energy: kinetic and potential. There exist different types of energy sources, some of which we will discuss in our work: thermal energy, radiant energy, chemical energy, mechanical nuclear energy, electrical energy, and radiant (solar) energy.

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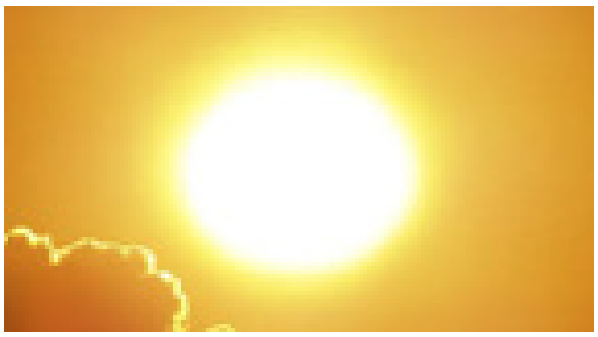
IMPLEMENTATION (LESSON PLAN) - CONTINUED

2. Provide a brief example of the kinds of energy shown in the chart. The following video can be used: https://www.youtube.com/watch?v=FX7T-QYTPho

EXPLAIN

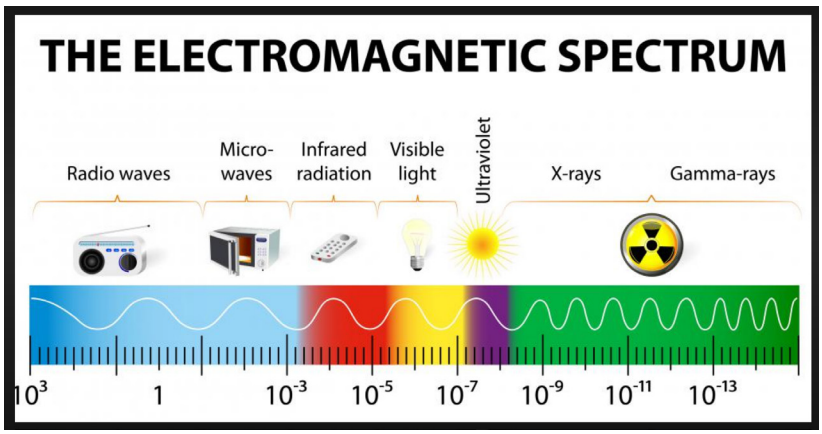
1. Review results as a whole group. Start by reviewing what energy is. Then move into any topics which may need review. The text, or attached videos, may be used with students as a refresher if needed.
2. Project the following visuals when possible:



What is energy?

- Energy = Work
- Work = Transfer of Energy
- Work is being done *ALL AROUND US, ALL THE TIME*
- 99% of our energy comes from the sun.

3. Remember that Solar Energy = Radiant Energy. Radiant energy transfer. Review the type of radiant energy on the electromagnetic spectrum and which waves have the most to do with solar and weatherization (especially insulation).
   a. Light up a clear incandescent light bulb
   b. Have students explain the radiant energy (electric energy makes the filament glow, which is heated in the process; both glow and infrared heat given off are examples of radiant energy.
   c. The sun reaching our skin is an example of pure radiation. Radiation left its source and traveled through space to warm another surface
   d. Heat and thermal energy is the most important to understand.



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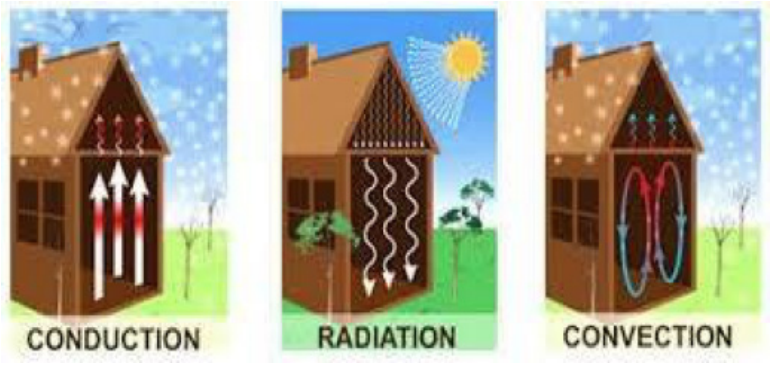
IMPLEMENTATION (LESSON PLAN) - CONTINUED

EXTEND

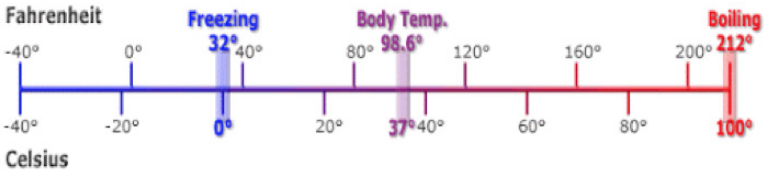
1. Review the heat transfer process. Use the heating pot and have students explain the heat transfer process. Provide support or information as needed.
2. Ask why this is the most important to understand in weatherization. (heat travels from the highest temp areas to lowest - related to air movement in a home or heat through windows and walls to the outdoors) Much of what an installer is doing is preventing heat transfer.



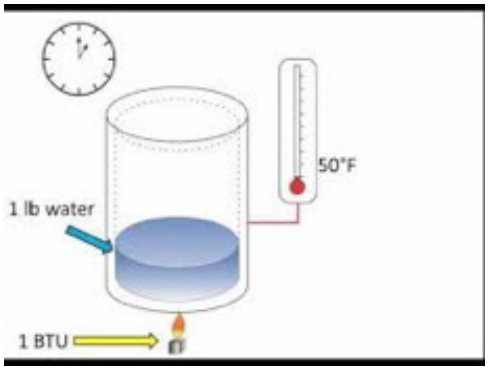
a. Additional heat transfer video and graphics can be found in the Appendix.

b. Additional resources are attached for additional topics:

i. Temperature Measurement: Celsius and Fahrenheit



ii. BTU's



iii. 1st and 2nd Laws of Thermodynamic

EVALUATE

- If most of the topics are covered, provide the quiz provided at the end of the resource section. Students should work in small groups to support each other. Use the quiz as much to clarify as to assess. Edit this quiz if some of the topics are not covered in your lesson.

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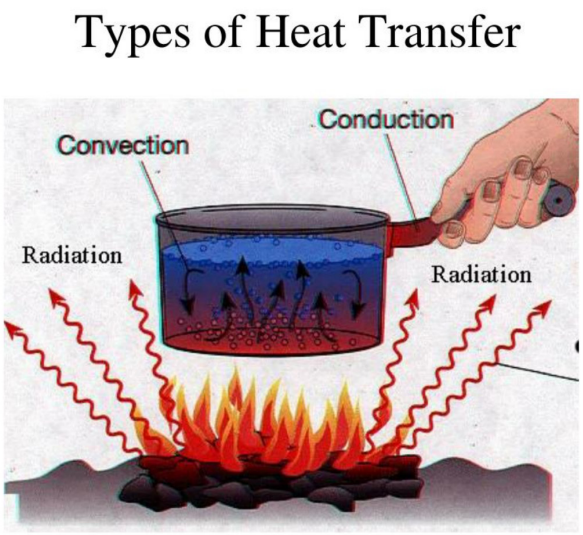
RESOURCES/LINKS

Potential and Kinetic Energy Quiz: can be used to explain rather than assess.

https://www.proprofs.com/quiz-school/story.php?title=potential-kinetic-energy

Principles of Heat Transfer

https://www.bpihomeowner.org/blog/technically-speaking-principles-heat-transfer



Types of Heat Transfer and How Insulation Works to Prevent Heat Transfer (Good insulation visuals)

https://www.youtube.com/watch?v=kB7ZeiHnEBw

Overview of Energy

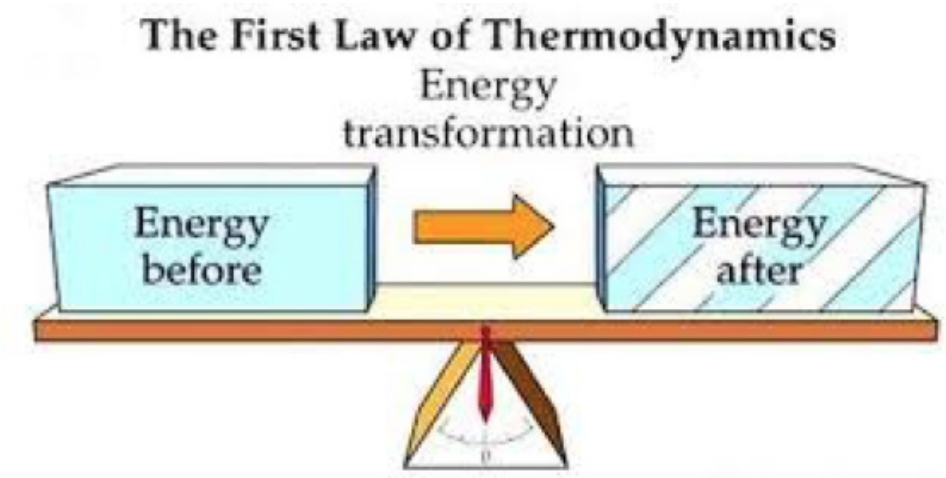
https://www.need.org/Files/curriculum/infobook/IntroS.pdf

1st and 2nd Laws of Thermodynamics

https://www.youtube.com/watch?v=v4zpQcAY5Eg

First Law of Thermodynamics:

https://www.youtube.com/watch?v=-8hpSl2MeyA



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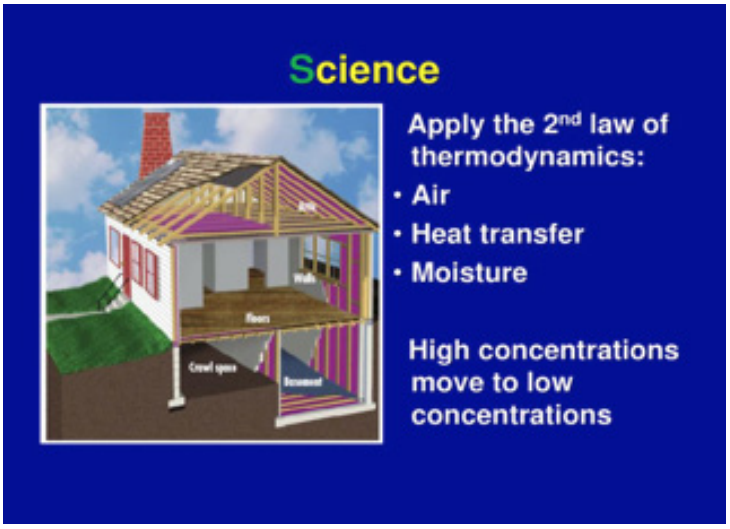
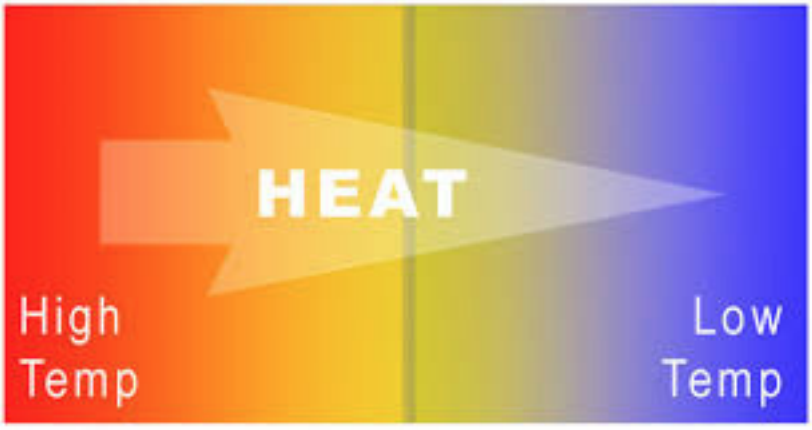
RESOURCES/LINKS (CONTINUED)

Second Law of Thermodynamics/Entropy

https://www.youtube.com/watch?v=DWiCaDPM7Hk





British Thermal Units

https://www.youtube.com/watch?v=OCrrQZ0ZjLs

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RESOURCES/LINKS (CONTINUED)

ENERGY QUIZ

1. What type of energy does the SUN give?
   - A. Mechanical
   - B. Electrical
   - C. Solar
   - D. Sound
   - E. None of the above
2. What three processes make up the heat transfer process?
   - A. Condensation, Convection, Confusion
   - B. Conduction, Pressurization, Condensation
   - C. Combustion, Condensation, Radiation
   - D. Conduction, Convection, Radiation
   - E. None of the above
3. What is true about energy?
   - A. It is the ability to do work
   - B. It cannot be created
   - C. It cannot be destroyed
   - D. Energy depends on sunlight
   - E. All of the above
4. When functioning, what type of energy does a gas heater have?
   - A. Nuclear
   - B. Chemical
   - C. Thermal
   - D. Mechanical
   - E. None of the above
5. What is true about the 2nd Law of Thermodynamics?
   - A. Total energy stays the same
   - B. Sound waves can cause heat
   - C. Energy goes from low temp areas to high temp areas
   - D. Energy goes from high temp areas to lower temp areas
   - E. None of the above
6. What is true about the 1st Law of Thermodynamics?
   - A. Energy can't be created
   - B. Energy can't be destroyed
   - C. Energy changes from one form to another
   - D. Total energy in a system remains the same
   - E. All of the above

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RESOURCES/LINKS (CONTINUED)

7. What energy does fire have?
    A. Chemical
    B. Nuclear
    C. Thermal
    D. Kinetic
    E. None of the above
8. Celsius and Fahrenheit are both examples of
    A. Potential energy
    B. Mechanical measurement
    C. Nuclear energy
    D. Temperature measurement
    E. None of the above
9. Light bulbs show off what type of energy?
    A. Radiant
    B. Chemical
    C. Electrical
    D. Sound
    E. None of the above
10. Delta T is the difference in:
    A. The air pressure of two areas
    B. The wind speed in two areas
    C. The difference in temperature in two areas
    D. The vibration of molecules in two areas
    E. None of the above
11. Temperature is:
    A. Hotness or coldness
    B. The measurement of the vibration of molecules
    C. A determination of internal energy
    D. A reading on a Fahrenheit thermometer
    E. All of the above
12. A British Thermal Unit is a quantity of heat needed:
    A. to raise air pressure of a room
    B. to increase temperature
    C. to make you feel warm
    D. to decrease temperature
    E. None of the above

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