LESSON

Principles of Energy and Physics

BIG IDEA(S)

The fundamental concepts of fundamental concepts of power and energy are important to understand for solar technicians and any career pathway related to 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
- Use entropy (Delta T) to explain how the stack effect works in a house

BRIGHT SOLAR FUTURES

SOLAR

TOPIC OF STUDY

Energy Systems

90 MINUTES

TASK LIST SUBCATEGORY

101 The principles and physics of energy

OVERVIEW

Power and Energy is covered in both the solar and weatherization fields. Kinetic and potential energy is reviewed as well as the important ideas of power and energy. For energy conservation measurement, Ohm's Law and forms of energy are important to understand since they are the big ideas that guide the work of a technician.

KEY TERMS

current
energy
work
mass
inertia
kinetic energy
potential energy
mechanical energy
chemical energy
Ohm's Law
kW (killowatt)
voltage (V or E)
resistance

STANDARDS

PA

3.2.12.B3. Describe the relationship between the average kinetic **molecular** energy, temperature, and phase changes.

3.2.10.B2. Explain how the overall energy flowing through a system remains constant; Describe the work- energy theorem. Explain the relationships between work and power

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

FURTHER DEFINITION OF KEY TERMS

Voltage: Electrical pressure (V or E)	Measured in Volts = V
Current: Electrical Flow	Measured in Amps = A
Power: Rate at which electricity is used (I)	Measured in Watts = W
Energy: amount of electricity used	Measured in Wh or kWh (Watt hours or kilowatt hours)
Power = Voltage x Current W = V x A	Energy = Power x Time

INSTRUCTIONAL

TEXTS/REFERENCES

Solar Photovoltaic Basics, Sean White, 2019, pp.23-30

Solar Electric Handbook: Photovoltaic Fundamentals, SEI, 2013. pp 40-46

MATERIALS NEEDED

Teacher Prep and Presentation:

- Use the following resource to solidify lesson plan: Introduction to Energy
- Electricity Basics Lesson Plan
- Work and Energy: https://www.youtube.com/watch?v=pmOXi-My6ZI, up to 1:32.

Content:

MATERIALS

- Balls of different sizes and weights to demonstrate energy principles
- Candle and matches to illustrate potential and kinetic energy; chemical, radiant, thermal energy; illuminated clear incandescent light bulb

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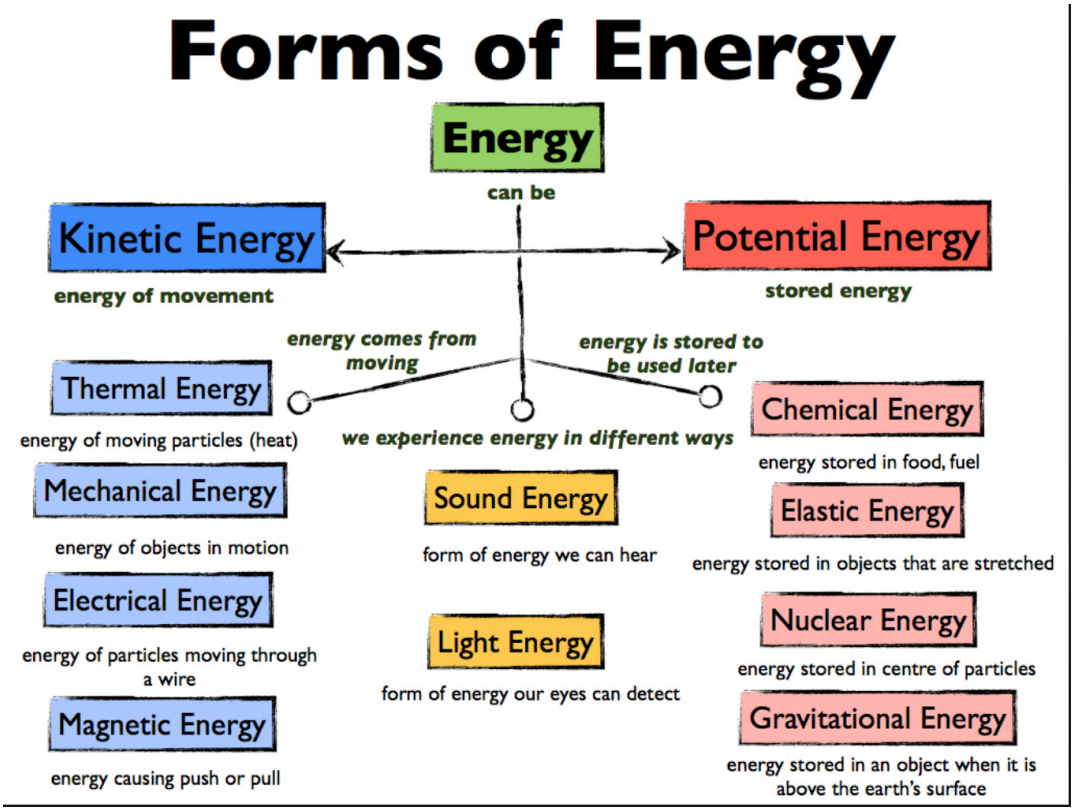
IMPLEMENTATION (LESSON PLAN)

ENGAGE

1. Candle activity
    a. 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).
    b. Review the demo and ask for deeper explanations of potential and kinetic energy illustrated. 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.
2. Additional Engagement/Intro
    a. Ask students to talk about what they think energy is in the normal conversational sense; what they think work is, what they think mass is, for all the vocabulary terms. Then tell them what the definitions are for each of these words within solar energy/physics Then show the two YouTube segments, stopping at minute 1:32 in the first. Have students ask questions, with both student and teacher responses. Bring in balls of differing sizes, place them on a surface and ask about their potential energy, kinetic energy. Then hold them above the surface asking the same questions.
    b. Next take the balls and push them gently to make them roll on the surface. Ask students which balls required more force to move and what would make them move faster. Which balls have the most kinetic energy when in motion? What happens when they strike one another?

IMPLEMENTATION (LESSON PLAN) - CONTINUED

3. Forms of Energy



EXPLAIN

1. Use the following as a resource to explain the physics behind energy.
    a. We use terms in normal conversation such as work and energy and we know what they mean. But in Physics they have very specific definitions. Energy is defined as the ability to do work. And work is the application of a force over a distance. The more energy used the greater the work. The greater the distance covered, the greater the work. There are many sources of energy and energy can take many forms. For instance, when we light a fire, chemical changes happen to the fuel that releases heat energy. In turn, that heat energy can be used to boil water, and the steam from the water can power an engine. The engine converts the heat energy into mechanical energy. Mechanical energy is simply the ability to move things around.
    b. An interesting thing about energy is that it cannot be destroyed. When you accelerate in a car, the chemical energy driving the engine is converted to the mechanical motion of the car. And when you slow down the car using the brakes, the original energy that moved the car is converted into heat energy by the brakes. The energy simply moves from one type to another but is not lost.
    c. Energy is made available for use when there is more of it in one place and less in another. An example is how the energy of something hot will flow to a material in contact with it that is cooler. This is how we heat our houses. We take heat generated in various ways, transfer it to something like air moving through the house, or pipes filled with water, and then have that hot material transfer its heat to the air within the house that is cooler.
    d. One of the most basic principles of the universe is that energy flows from hot to cold but never in the opposite direction. And so there is an overall motion towards sameness as the amount of heat in things is equalized.

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IMPLEMENTATION (LESSON PLAN) - CONTINUED

   e. In physics, energy is divided up into kinetic energy and potential energy. This just means, we divide things into those that are moving (kinetic) and things that could move if allowed to (potential).

2. Review the formula information in the Vocabulary Section
3. Power: is measured in WATTS. Demonstrate how W = V x A, where Watts stay the same and voltage and current differ
   a. 120W = 120 V x 1A and 120W = 12 V x 10 A
   b. Explain Watt and kilowatts
   c. Review larger units like gigawatt = one billion watts; a terawatt is one trillion watts
   d. Present Watts calculations for a PV array (SEI, p 43)

EXPLORE

1. Review Ohm's law: Ohms Law Tutorial and Power in Electrical Circuits
2. Present simple algebra triangle formulas for power calculations and provide word problems for calculations.
   a. Example

      PROBLEM #1:

      A frying pan is connected to a 110-volt circuit. If the resistance of the frying pan is 10 ohms, how many amperes does the frying pan draw?

      Solution: The voltage and the resistance are given, so we can just use the formula to find the current.

      current = voltage resistance

      current = 110 volts 10 ohms

      current = 11 amperes.

      Additional Problems: https://www.rcboe.org/cms/lib/GA01903614/Centricity/Domain/9473/03_08_18_ohms_law_worksheet_alt.pdf

EXTEND

- Calculating Power and Energy in PV Systems
  - Demo the NREL PVWatts Calculator

HOMEWORK

Have students look around their homes and make a list of all the different types of energy they see – examples of heat energy, mechanical energy, chemical energy etc.

MEETING INDIVIDUAL NEEDS

Use of YouTube segments for visual learners. Avoidance of any complex mathematical formulas. Discussion of examples from everyday life.

RESOURCES/LINKS

Basic Secondary Curriculum Unit: The NEED Project

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

Overview of Energy:
Introduction to Energy

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