



1.1 – DEFINING ENERGY

Learning Outcomes:

By the end of this lesson, the student will be able

1. To explain the concept of energy and its various forms.
2. To describe the nature of energy changes that accompany chemical and physical changes.
3. To describe the relationship between energy and heat.

ENERGY

- Energy can be described as the capacity to do work, or the ability to move or cause change in matter.

TWO MAIN TYPES OF ENERGY

1. **Potential Energy : stored energy**
 - Stored in springs, batteries, food and fuel.
 - Examples: Chemical, elastic, nuclear, electromagnetic, gravitational potential energy
2. **Kinetic Energy : energy of motion**
 - The faster an object moves, the higher the energy.
 - Examples: electrical (flow of electrons), sound (movement of air molecules), thermal/heat (movement of atoms), any moving object (car, person, etc.)

FORMS OF ENERGY

1. **Thermal Energy (Heat Energy)**
 - Thermal energy is kinetic energy associated with the random motion of atoms and molecules.
 - Temperature is a quantitative measure of "hot" or "cold." When the atoms and molecules in an object are moving or vibrating quickly, they have a higher average kinetic energy (KE), and we say that the object is "hot."
 - When the atoms and molecules are moving slowly, they have lower KE, and we say that the object is "cold".
 - Example: Thermal energy from a hot stove is transferred to a metal pot and causes the water molecules to move faster increasing the temperature of the water.
2. **Chemical Energy**
 - Potential energy stored in bonds of atoms and molecules.
 - Example: Wood, coal, gasoline, and natural gas are fuels that contain chemical energy.
3. **Electrical Energy**
 - Kinetic energy from the movement of charged particles called electrons.
 - Example: Lightning, household current
4. **Sound Energy**
 - Sound energy is a form of energy that is associated with vibrations of matter.
 - Example:
A vibrating drum transfers energy to the room as sound. Kinetic energy from the moving air molecules transfers the sound energy to our eardrums. Kinetic (movement) energy in the sticks is being transferred into sound energy.
5. **Light Energy**
 - Produced by the vibrations of electrically charged particles. It can be transmitted through a vacuum (a space without matter)
 - Example: The energy used to cook food in the microwave
6. **Nuclear Energy**
 - Nuclear energy is the energy that is trapped inside each atom. Nuclear energy can be produced either by the fusion (combining atoms) or fission (splitting of atoms) process.
 - Example: Atomic bombs, nuclear power plants, nuclear submarines and the sun

HEAT

- Heat is the flow of thermal energy between two objects, from the warmer one to the cooler one, because of a difference in their temperatures. Thus, heat is a process and not a quantity.
- Matter undergoing chemical reactions and physical changes can release or absorb heat. A change that releases heat is called an *exothermic process*. A reaction or change that absorbs heat is an *endothermic process*.

CONVERSION OF ENERGY

- Energy conversion is a change in energy from one form of energy to another.
- Any form of energy can be converted into any other form of energy. In every conversion, some energy is always converted into thermal energy.

Examples:

Conversions involving chemical energy:

- Food is digested and used to regulate body temperature
- Fuel is burned to cook food
- During photosynthesis, plants use light energy to produce new substances with chemical energy.

Conversions involving electrical energy:

- Light bulb: electrical energy to light
- Microphone: electrical energy to sound energy
- Battery: chemical energy to electrical energy

CONSERVATION OF ENERGY

- A *thermodynamic system* is quantity of matter of fixed identity, around which we can draw a boundary. The *boundaries* may be fixed or moveable. Everything outside the boundary is the *surroundings*.
- Law of Conservation of Energy:
 - Energy can neither be created nor destroyed. Energy can be changed from one form to another, but all the different forms of energy in a system always add up to the same total amount of energy, no matter how many conversions occur.
 - Conservation of energy requires that the total energy change in the system and the surrounding must be zero.

$$\Delta Energy_{universe} = 0 = \Delta Energy_{system} + \Delta Energy_{surroundings}$$

Where: Δ is the symbol that is used to mean *change*

UNITS OF ENERGY

- 1 *Joule (J)* is the MKS unit of energy, equal to the force of one Newton acting through one meter.
- 1 *Watt (w)* is the power of a Joule of energy per second
- 1 *calorie (cal)* of heat is the amount needed to raise 1 gram of water 1 degree Centigrade.

$$1 \text{ calorie (cal)} = 4.184 \text{ J}$$

- A *BTU* (British Thermal Unit) is the amount of heat necessary to raise one pound of water by 1 degree Fahrenheit (F).

$$1 \text{ British Thermal Unit (BTU)} = 1055 \text{ J}$$

$$1 \text{ BTU} = 252 \text{ cal} = 1.055 \text{ kJ}$$



ACTIVE LEARNING EXERCISES:

1. Fill in the following table with what kind of energy each example contains:

- | | |
|---------------------------------|-------|
| a. A burning candle | _____ |
| b. A glass on a table | _____ |
| c. A green plant | _____ |
| d. A piece of radioactive metal | _____ |
| e. A cup of hot chocolate | _____ |

2. Name a common device used to accomplish each change:

- | | |
|---|-------|
| a. Electrical energy to thermal energy | _____ |
| b. Electrical energy to sound energy | _____ |
| c. Electrical energy to light energy | _____ |
| d. Mechanical energy to electrical energy | _____ |
| e. Chemical energy to electrical energy | _____ |

3. Complete combustion of 2.0 metric tons of coal to gaseous carbon dioxide releases 6.6×10^{10} J of heat. Convert this energy to

a. Kilojoules

b. Kilocalories

c. British thermal units

4. Thermal decomposition of 5.0 metric tons of limestone to lime and carbon dioxide absorbs 9.0×10^6 kJ of heat.

Convert this energy to:

a. Joules

b. Calories



UNIVERSITY OF NEGROS OCCIDENTAL – RECOLETOS
IQuAME(At), CHED Autonomous University
#51 Lizares Avenue, Bacolod City 6100

COLLEGE OF ENGINEERING

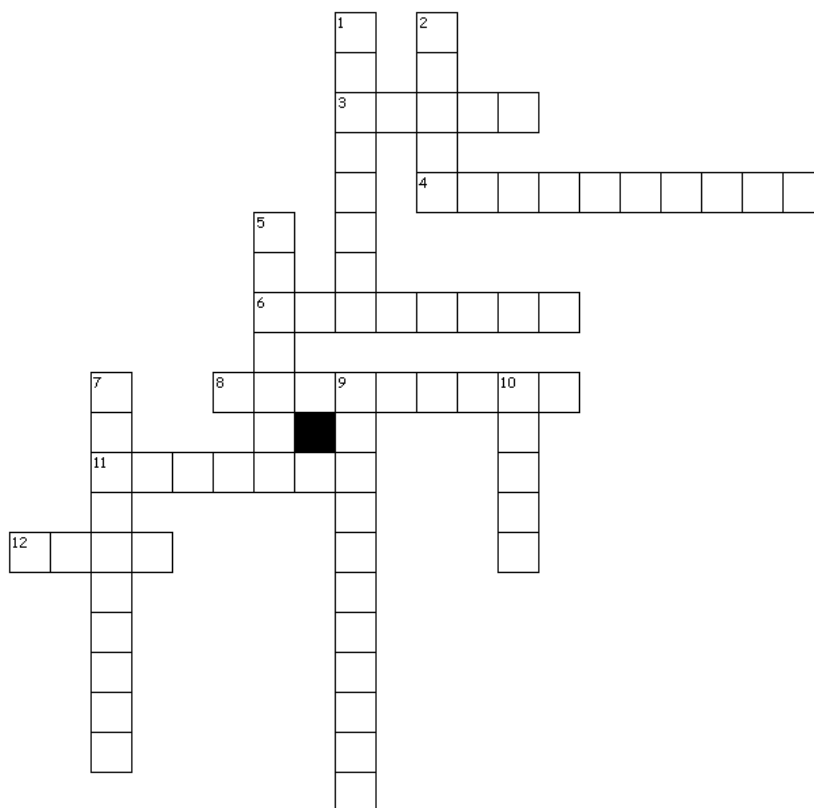


WORKSHEET NO. 3
CHEMISTRY FOR ENGINEERS (Lecture)

Name: _____ Sec: _____

1. Complete the puzzle.

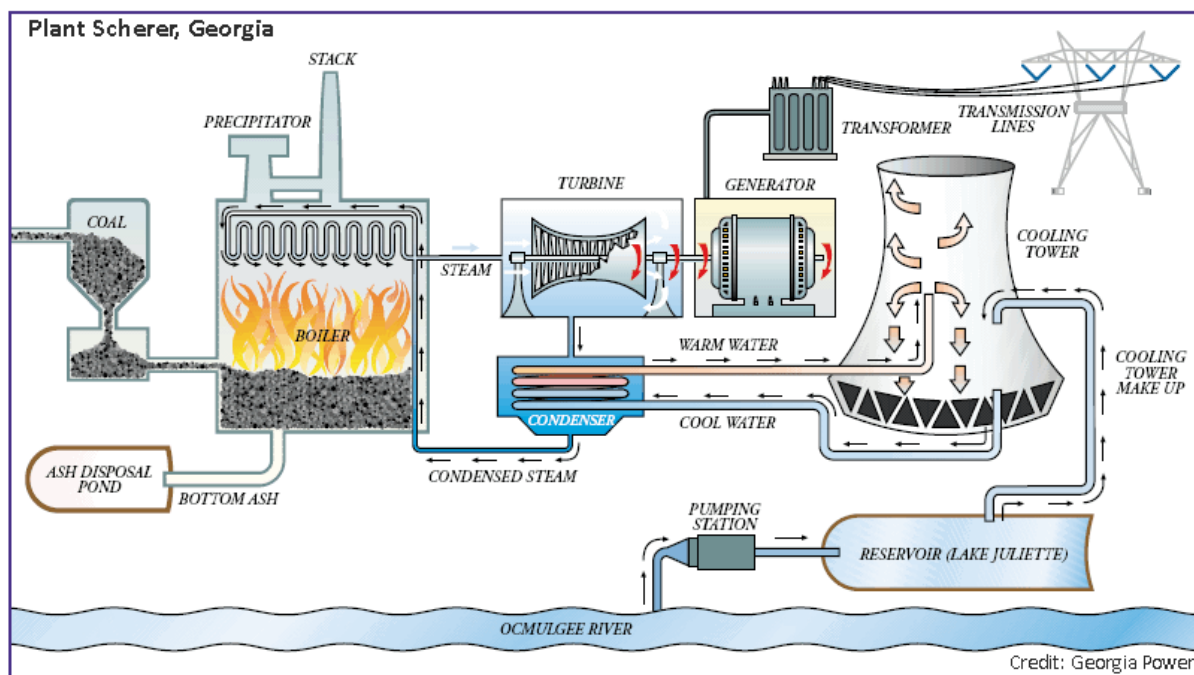
- Across 3. A form of energy that travels as waves through the air and some solids and liquids.
Across 4. Lightning is a form of ____ energy
Across 6. Batteries and plants store this kind of energy
Across 8. Fuels such as the wind and sun that can generate power without being used up.
Across 11. A measure of energy that is used for measuring the amount of energy in food.
Across 12. The burning of wood releases this form of energy. This energy is created as a result of the movement of atoms.
- Down 1. A type of potential energy that is made from fossil fuels.
Down 2. Unit of energy
Down 5. The energy that is stored within atoms.
Down 7. A form of energy that results from the movement of machine parts.
Down 9. A form of energy that is used in homes and is produced by the movement of electrons
Down 10. A form of energy that travels as waves from the sun to Earth





2. The figure below depicts an electric power plant. In the figure identify where:

- Potential (chemical) energy of the fuel is converted to heat.
- Kinetic energy of water molecules is converted to mechanical energy.
- Mechanical energy is converted to electrical energy.
- Electrical energy is converted into forms such as heat and light.

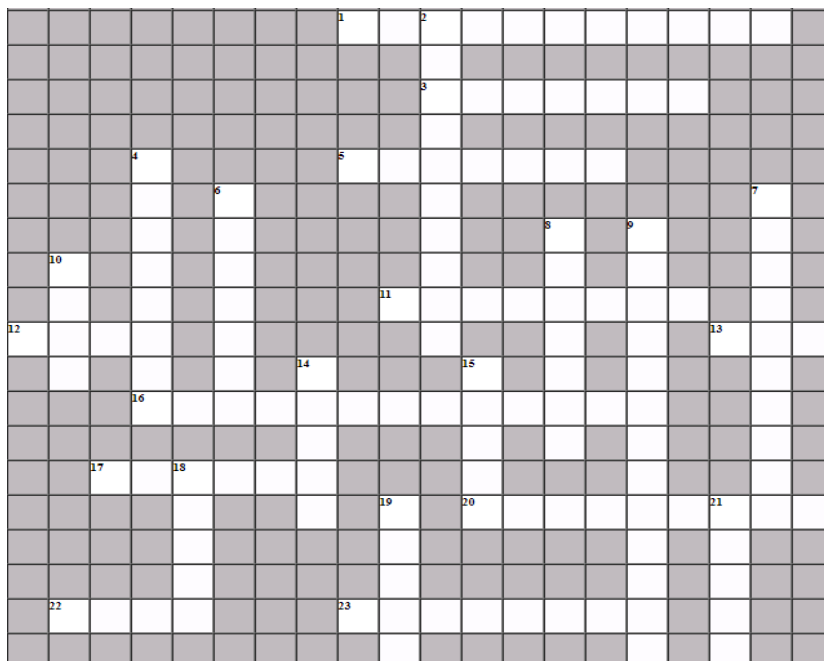


3. Carry out the following conversions of energy units:

- 14.3 Btu into calories

- 1.4×10^5 cal into joules,

- 31.6 mJ into Btu



<p>across 1. A form of energy that is used in homes and is produced by the movement of electrons.</p>	<p>across 3. The energy stored in compressed springs is known as ____ potential energy.</p>	<p>across 5. A storage of energy invented by humans and that is filled with chemicals.</p>	<p>across 11. A type of potential energy that is made from fossil fuels.</p>
<p>across 12. The burning of wood releases this form of energy. This energy is created as a result of the movement of atoms.</p>	<p>across 13. Animals store their excess energy in this form. They can use this later on if they do not have enough energy.</p>	<p>across 16. One of the gases released into the air when fossil fuels burn. (2 words)</p>	<p>across 17. A type of fuel formed from the remains of plants or sea creatures millions of years ago.</p>
<p>across 20. Fuels such as the wind and sun that can generate power without being used up.</p>	<p>across 22. Humans get their energy from this.</p>	<p>across 23. Batteries and plants store this kind of energy.</p>	
<p>down 2. Lightning is a form of ____ energy.</p>	<p>down 4. A form of energy that results from the attraction of objects that are made of iron.</p>	<p>down 6. The energy that is stored within atoms.</p>	<p>down 7. A form of energy that results from the movement of machine parts.</p>
<p>down 8. A measure of energy that is used for measuring the amount of energy in food.</p>	<p>down 9. Fuels such as coal and oil that can be used only once.</p>	<p>down 10. Any type of material that stores energy and can be burned to supply heat.</p>	<p>down 14. The basic unit of energy that scientists use.</p>
<p>down 15. Earth gets most of its energy from this form of energy.</p>	<p>down 18. A form of energy that travels as waves through the air and some solids and liquids.</p>	<p>down 19. A form of energy that travels as waves from the sun to Earth.</p>	<p>down 21. Chemical energy is stored in the ____ of molecules.</p>