

Chemical Energy Conversions

Vanderbilt Student Volunteers for Science

2018-2019 VINSE/VSVS Rural

Important!!!

- Please use this resource to reinforce your understanding of the lesson! Make sure you have read and understand the entire lesson prior to picking up the kit!
- We recommend that you work through the kit with your team prior to going into the classroom.
- This presentation does not contain the entire lesson—only selected experiments that may be difficult to visualize and/or understand.

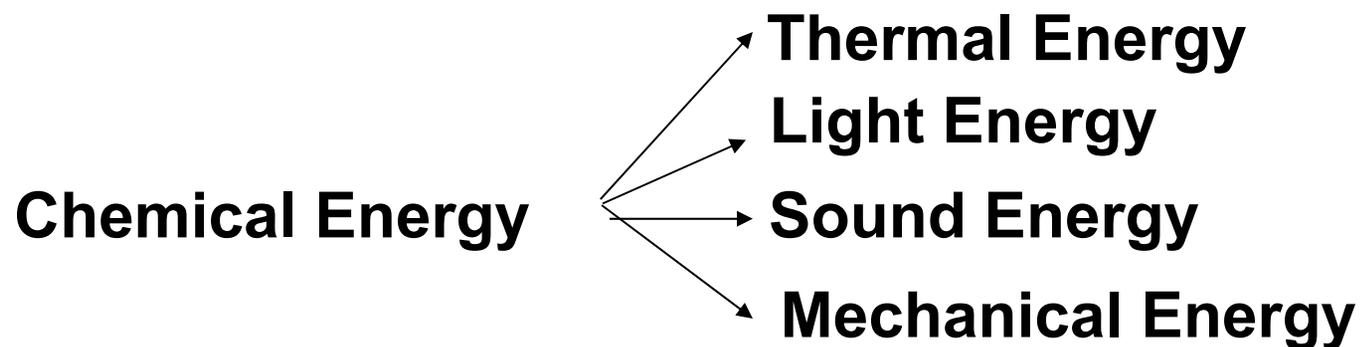
Why is the science in this lesson important?

- One popular field in engineering is petroleum engineering, where scientists work to turn simple resources like oil and gas into usable energy.
- Hydrogen is a very efficient energy carrier and is often produced through the means of biological, thermochemical, and electrolytic processes. The challenge is to be able to obtain hydrogen from renewable energy sources instead of fossil fuels. Hydrogen has great potential to be a clean and efficient power - a fuel cell that turns the chemical energy of hydrogen into electricity combined with an electric motor could be very successful in transportation applications.

I. Introduction

Learning Goals: Students understand that chemical energy is a form of potential energy that is stored in the bonds of molecules

- Ask students: “What are the different forms of energy?”
- This lesson emphasizes **Chemical Energy conversions**. (However, note that conversions can go both ways.)
- Write the following on the board:



II. Demo: Chemical Energy Conversions

Dust Can Explosion

Learning Goal: Students observe at least 4 chemical energy conversions.

Follow these steps exactly for a successful explosion!

1. Show students the "dust can".
2. Light the tea light candle and place it in the coffee can. Do not place it too away from the hole in the side of the can.
3. Load the pipette with a small amount of lycopodium dust powder (enough to fill the tip). DO NOT turn the pipette upside down. Show the pipette to the students. Tell students that there is a hole in the side of the can.
4. Ask students to predict what will happen when you 'blow' the dust into the can.

(Continued on next slide)



II. Demo: Chemical Energy Conversions Dust Can Explosion

5. Holding the pipette at an angle (aiming down with about a 30° angle from horizontal), place the pipette in the hole (make sure the pipette is snug) and angle it toward the flame.

6. Place the lid on the can (do not do this until you are ready to squeeze the pipette as the candle will quickly go out).

7. Squeeze firmly on the pipette and leave the pipette in the hole after squeezing. There will be a flash of fire, a loud explosion, and the lid will blow off the can.

Note: If the explosion does not happen on the first try, please try again. Some groups have to try this three or four times to achieve the desired results. Please also stand at a safe distance



III. Chemical Energy → Light Energy

Lightstick Demonstration

Learning Goals: Students can observe the release of light energy to determine that a chemical energy conversion has occurred

- Hold up the large lightstick.
- Bend the plastic tube slightly to break the thin vial inside so that the 2 chemicals mix.
- Shake the lightstick, then walk around the room to give the students a closer look.
- Ask the students what was the chemical energy converted to?
 - **Chemical to Light**

IVA. Chemical Energy → Thermal Energy

Hand warmer Demonstration

Learning Goals:

Students can observe the release of thermal energy to determine that a chemical energy conversion has occurred.

Students can explain how the recyclable hand warmer illustrates the Law of Conservation of Energy.

- **Recyclable Hand-Warmer**
 - Distribute the **8 hand warmers** (in plastic casing) to every other pair.
 - Explain that it contains a supersaturated sodium acetate solution.
- **One student should use a finger tip to firmly press and**
- **release the metal activation button or bend the metal disc (hand warmers vary in their activation mode.)**
 - Students should see white solid beginning to form around the button/disc. If they don't, they need to repeat the activation. It's pretty obvious when it works. (Try using the tip of a finger to press down on the button.)
- **Tell students that there is more chemical energy in liquids than in solids.**
 - Pressing the button makes the solution crystallize to a solid and releases energy.
- Ask the students what was the chemical energy converted to?
 - **Chemical to Thermal**



IVB. Chemical Energy → Thermal Energy

A chemical reaction

- Distribute the **8 HotHands** hand warmers to every other pair.
- Have one of the students tear open the plastic covering and feel it.
 - Note that it is the same temperature as their hand.
- Tell them to shake it and set it aside for a few minutes.
- **Have the students look at their Instruction sheets and read the ingredients.**
 - Record the ingredients on the board: iron powder, water, salt, activated charcoal and vermiculite.
- **Tell the students that the “missing ingredient” that is needed to make the hand warmer warm up is oxygen.**
 - When the plastic is removed, the pouch is porous enough to let air (and therefore oxygen) react with the iron inside, which releases heat. This is rusting!



IVB. Chemical Energy → Thermal Energy cont'd.

- Take the empty 4oz jar, cut open a hand warmer pouch and pour the contents inside the jar.
 - Let the students look at this jar and compare what the contents look like with the jar that contains the contents of a HotHands hand warmer that have been exposed to air for 24 hours.
- In the 24-hour jar, the black color of iron powder has changed to a brownish, somewhat clumpy solid, which is iron oxide. (This is evidence of a chemical change.)
- Have students feel their hand warmer (It should feel warm now)
- Ask the students what was the chemical energy converted to?
 - **Chemical to Thermal**

V. Thermal Energy → Chemical Energy

(Dissolving potassium chloride)

Learning Goals: Students can observe the conversion of thermal energy to chemical energy.

- **Students should work in pairs and put on their SAFETY GOGGLES.**

Show students how to read their thermometer correctly:

- Look at the diagram of the thermometer on their Observation Sheet.
- Explain that each line represents a temperature degree, and that the temperature is read by observing where the top of the red liquid is.
- Tell them to find the line that represents 20 degrees C, and to put a mark next to the line which they think is even with the top of the **BLACK** line in the middle of the thermometer (tell that this line represents the red liquid in their thermometer)



V. Thermal Energy → Chemical Energy Cont'd.

Tell students to:

1. Fill the beakers to the 50 mL mark with water and add it to the Styrofoam cup.
 2. Put the thermometer in the water, wait 1 minute and measure the temperature.
 3. Record the temperature.
 4. Add two spoons of potassium chloride and stir carefully with the thermometer for about 2 minutes.
 5. Record the lowest temperature reached.
 6. Subtract the 2 temperatures and record the value.
- Ask the students what they noticed.
The water got colder.
 - Explain that this means that thermal energy was used and converted to chemical energy.
 - Chemical to Thermal



Commercial Cold Packs

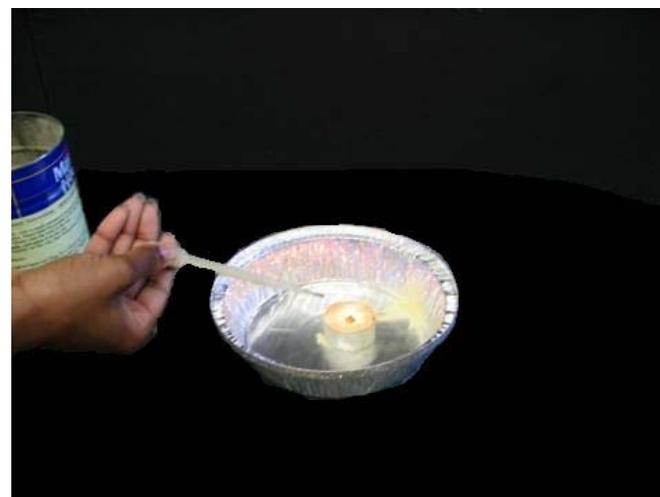
- Ask students if they know what a cold pack is. When is it used?
- Activate it and pass it around the room for the students to feel.
- Explain: Commercial cold packs contain separate bags of ammonium nitrate and water. The cold pack is activated by squeezing to break the plastic divider between the water and ammonium nitrate so ammonium nitrate mixes with the water.
- When ammonium nitrate is dissolved in water, thermal energy from the water is absorbed.
- This is another **Thermal to Chemical** conversion

VI. Demo: Chemical Energy conversion to Thermal, Light, Sound, & Mechanical Energy

Return of the Dust Can Explosion

Learning Goals: Students can identify the chemical energy conversions to thermal, mechanical, light, and sound energy.

- Show the students the lycopodium "dust" powder.
- Light the tea candle and place it on the aluminum pan.
- Load the pipette with enough dust powder to fill the tip. **Do not turn the pipette upside down.** There must be powder at the **tip** of the pipette for this to work.
- Hold the pipette so the tip is about 10 inches above the flame and squeeze the pipette bulb to release the lycopodium powder into the flame.
- There will be a flash of fire.
- Ask students: Why was there a flash of fire? *It was caused by the rapid burning (combustion) of the lycopodium powder.*



VI. Demo: Chemical Energy conversion to Thermal, Light, Sound, & Mechanical Energy

Return of the Dust Can Explosion

- Repeat the Dust Can Demonstration.
- Ask the students which chemical energy conversions were involved?
 - Chemical Energy to Thermal, Light, Sound and Mechanical Energy



VII. Review Questions

Learning Goals: students review the different forms of energy and the Law of Conservation of Energy.

- **Go over the observation sheet with the students, and ask them to answer the review questions. Discuss the review questions, including reference to vocabulary words whenever possible.**
- **Can energy ever be created or destroyed? Why not?**
This is The Law of Conservation of Energy
- **What are the different forms of energy?**
 - Different forms of energy covered in this lesson include electrical, chemical, light. Other forms include mechanical, heat, nuclear, electromagnetic (light is just one part of electromagnetic spectrum).

What type of energy conversions do the following represent?

 - Turning on a flashlight (chemical to electrical to light)
- **What are some other types of energy conversions that we have not discussed today?**
 - Examples include: nuclear to electrical, electrical to heat, electrical to mechanical (electric cars), chemical to mechanical (burning gasoline in internal combustion engines – cars, trucks).

Clean-Up

- **Pour the solutions from the styrofoam cups into the waste container, or pour down the sink (chemicals are safe to pour down sink at school).**
- **Put the cups into the trash bag before putting them back in the kit box.**
RETURN ALL CUPS ETC TO THE VSVS LAB
- **Make sure to return all recyclable hand warmers to the kit!**