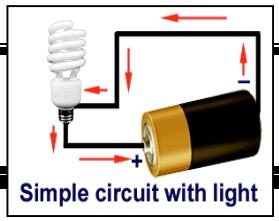
# Science Energy Literacy and Activities

# Elementary School Curriculum

*Created by National Renewable Energy Laboratory (NREL)*

Click on the links below to take you to the Chapter heading:




# Circuits

**Objective:**
We will learn about electricity by making a simple circuit with your own bodies!

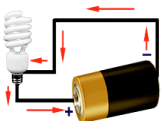
**Science Background**

**Electricity** is a **versatile** form of energy. Windmills, water wheels and coal power plants, all have **generators**, which **convert** energy from the wind, water, or coal into electricity. The electricity can then be used to make light bulbs glow and electric heaters warm. It can make the sound in speakers and the picture on TV.

Electricity is caused by the movement of **electrons**. Those electrons must be able to flow in order to have an electrical **current**. When the electrical current is a complete path, like a circular path, it is called a **circuit**. The circuit allows the electrons to flow into an item, provide the energy, and back out. If the circuit is **interrupted** then whatever you are trying to power will not work.

You will read about electricity, and then build a simple circuit.





# Reading

**Discussion:** Electricity travels through circuits allowing it to provide power to appliances, lights and other items powered by electricity What do you know about electricity? What are some items powered by electricity?

**Prediction:** Electricity is a kind of energy that gives us heat, light and power. What do you think your book will be about?

**Book List:**

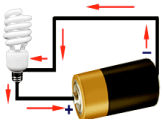
Discovering Electricity
Rae Bains — ISBN: 0-89375-565-6
Grade Level: 3-4th Grade
AR Points:

Electrical Circuits: Harnessing Electricity
David Dreier — ISBN: 0756532671
Grade Level: 7.4
AR Points: 1.0

What Is Electricity?
Lisa Trumbauer — ISBN: 0516258451
Grade Level: 2.4
AR Points: 0.5

**Summary:** How would you summarize your book for another student? Would you recommend it? Why or why not?





# Reading Comprehension Questions

Book Title: _____

Was your book fiction or non-fiction?_____

**Fiction Comprehension Questions**

1. Who is the main character of the story? _____

_____

_____

2. Can you describe the setting? _____

_____

_____

3. What is the main idea of the story? _____

_____

_____

**Non-fiction Comprehension Questions**

1. What is the main idea of the book? _____

_____

_____

2. What is the author's purpose for writing the book? _____

_____

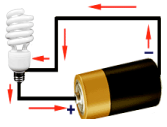
_____

3. List three pieces of information that you have learned from your reading.

_____

_____





# Vocabulary

Versatile - _____

_____

_____

Generators - _____

_____

_____

Convert - _____

_____

_____

Electricity - _____

_____

_____

Electrons - _____

_____

_____

Provide - _____

_____

_____

Circuit - _____

_____

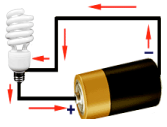
_____

Interrupted - _____

_____

_____





# The Circuit Board

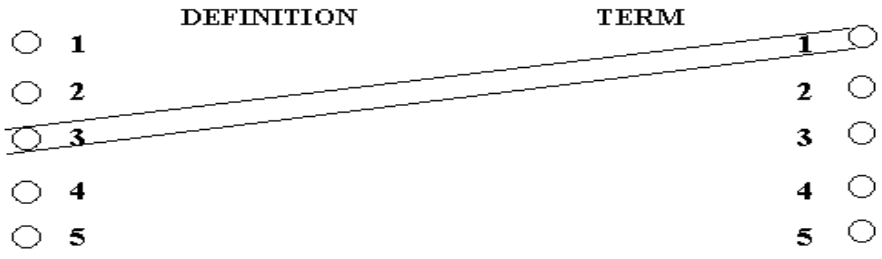
**Hypothesis:** What is required for electricity to do work?

**Materials:** Energy Ball, 8 x 4 in. Sheet of Aluminum foil, Scissors, Masking tape, 4 Small Paper Clips (metal), one-hole punch, 1/2 Manila folder, quiz board template

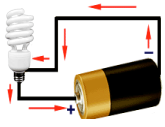
**Procedure:**

1. Cut a Manila folder along the fold and share it with someone.
2. Cut 6 strips of aluminum foil about 8 inches long and $\frac{1}{2}$ inch wide and put them aside. (Try your best not tear the foil, but you can repair it with tape.)
3. Take the quiz board template and tape it to the Manila folder.
4. Read the first term on your quiz board and punch a hole to the left of the term. Find the correct answer on the right and punch a hole on the right.
5. Turn the quiz board over and place it face down so the back is facing you.
6. Take one of the aluminum strips and cover the term hole and the definition hole making sure to keep the aluminum strip flat and smooth. This will create a path for electricity to flow through. Cut off any excess foil on the ends.
7. **Completely** cover the aluminum strip with masking tape to secure it to the back of the board and to insulate the strip from the other four circuits you will be making.

**Back Side of Quiz Board**

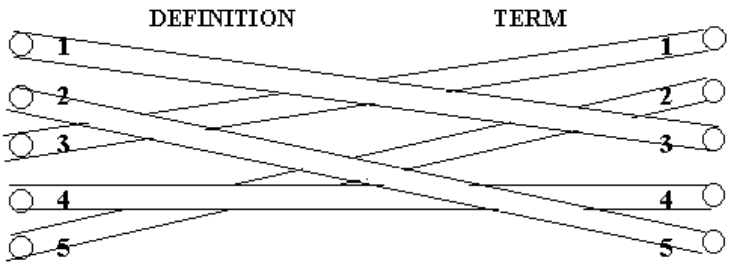



**All tin foil strips are completely covered in masking tape for insulation**



8. Now repeat the same steps for the remaining terms and definitions. Make sure that the foil of each circuit is flat, smooth and completely covered by masking tape before going on to the next circuit.
9. Once you have completed all five simple circuits the back of your board should look similar to the picture below.

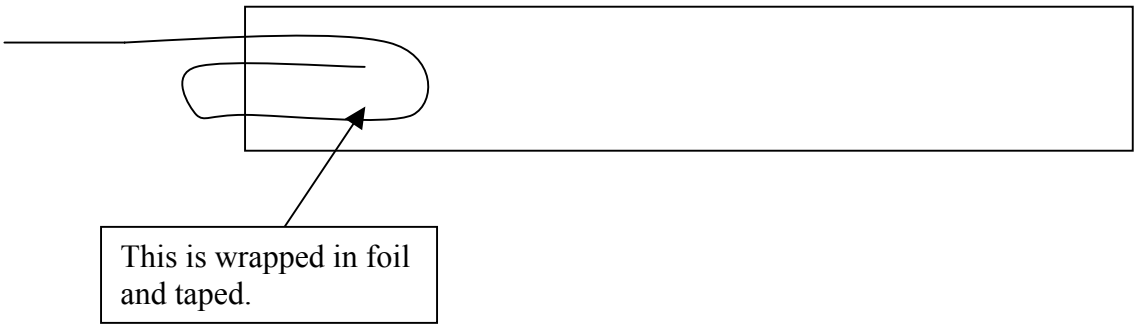
**Back Side of Quiz Board**




**All tin foil strips are completely covered in masking tape for insulation**

10. Now unravel the paperclips so they look like this:

11. Take a paper clip and tape the longer side (the part you unraveled) and tape it to one of the metal places on the UFO ball. Repeat for the other side.
12. Cut the last piece of foil in half. Using one piece of foil, wrap part of it, lengthwise, around one of the remaining paper clips on the unraveled part. Then tape this section all the way around. Then repeat for the other side. It should look like this:

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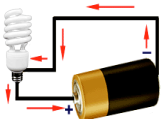
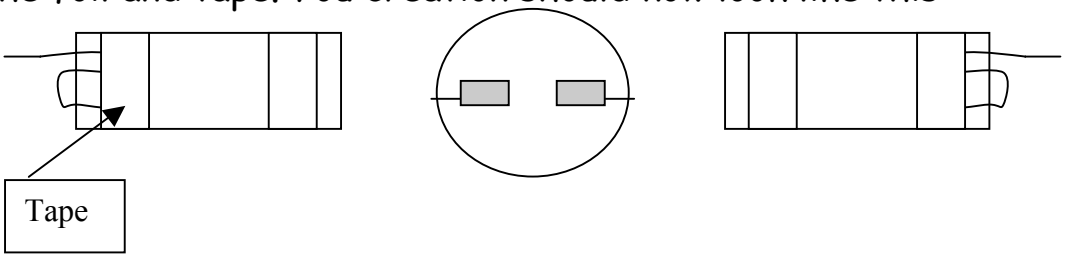


13. Wrap the paper clip attached to the energy ball with the other side of the foil and tape. You creation should now look like this:



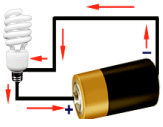

14. Picking up the taped section furthest away from the ball touch the paperclip end to the foil in the hole next to the correct answer. Both wires should be touching the foil at the same time. If your circuit was done correctly, you should hear the ball and see it light up. Be careful only to touch the taped part (add more tape if you need to) and make sure you don't tear the foil. If you do, you can always repair it with tape.

**Data:** (Correctly wired Quizboard)

**Conclusions:**

1. What happens when the buzzer is not connected to the right answer?
2. Why does the buzzer only make noise when it's touching the correct answer?
3. What do you think happens to an electrical circuit when you turn off a light switch?
4. What is required for electricity to do work?
5. Was your hypothesis correct?





# Teacher Resources

**On-line:**

All About Circuits:
http://www.allaboutcircuits.com/vol_1/chpt_1/3.html
The Energy Story:
http://www.energyquest.ca.gov/story/chapter04.html
Georgia State University: http://hyperphysics.phy-astr.gsu.edu/hbase/electric/watcir.ht

**Materials:**

If you do not hear the buzzer, check each of the following:

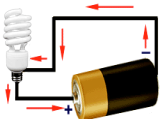
- The foil is connected properly on the back
- The questions are answered correctly
- The foil is smooth with no wrinkles, twists or tears.
- The paperclips are attached to the ball.

If you hear the buzzer before the answers are quiz board is touched make sure the student is only touching the taped part of the foil (you may need to add more tape).

**Suggestions:**

1. Give students the UFO ball, foil, and challenge students to make the buzzer buzz. It will take students some time to come to an understanding of the complete circuit necessary to create the sound.
2. Have the students use different materials other than the foil and paperclips and see which conduct electricity and make a circuit.
3. Have students create their own quiz boards based on the book they read.

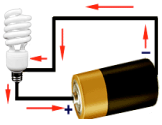




4. Have students trade quiz boards to test each others knowledge.
5. Have the students make a circuit using their own bodies. Have the students stand around in a circle and hold hands. Two of the students grab one end of a completed energy ball buzzer and the circuit should be complete. Have two of the students unclasp their hand and see what happens to the buzzer.
6. Explain to the students that the battery for the UFO ball is inside but the circuit is outside. Have them explain what they think happens in a flashlight when you turn it on. Is the circuit completed inside or outside the flashlight?

**Standards (see appendix A for detailed overview):**
**Physical Science 3 c)** - Electricity in circuits can produce light, heat, sound, and magnetic effects. Electrical circuits require a complete loop through which an electrical current can pass.





# The Circuit Quiz

| TERM | DEFINITION |
| --- | --- |
| Battery | A tiny particle responsible for creating electricity. |
| Electricity | A steady flow of electricity. |
| Electron | A device that stores electricity in chemicals. |
| Circuit | A complete or unbroken path that allows electricity to flow. |
| Current | A type of energy that gives us heat, light, and power. |

# Circuits Word Search

W Q B D D U L C Y T H C B O S
V Z Y M T E I H Z T V V L L R
Y T I C I R T C E L E A Q C O
N V I V C Z O P C A I Z Q H T
H G P U L U Z C U E A A S P A
L D I O Y B R C L R A Q A S R
P T D P P B Y I O S R P C F E
R P E L E C T R O N S E B S N
O U Y Y M A H C U G V L T P E
V O K B S Y I X F O I E M N G
I Z E R C V E D X L J L R M I
D M E J O Z S S T F D L O T Y
E V P I Q W M Z T H C S A M Y
D I D I G J Z I Z I U W N L Q
E G H F L W R Q N P Q L J X S

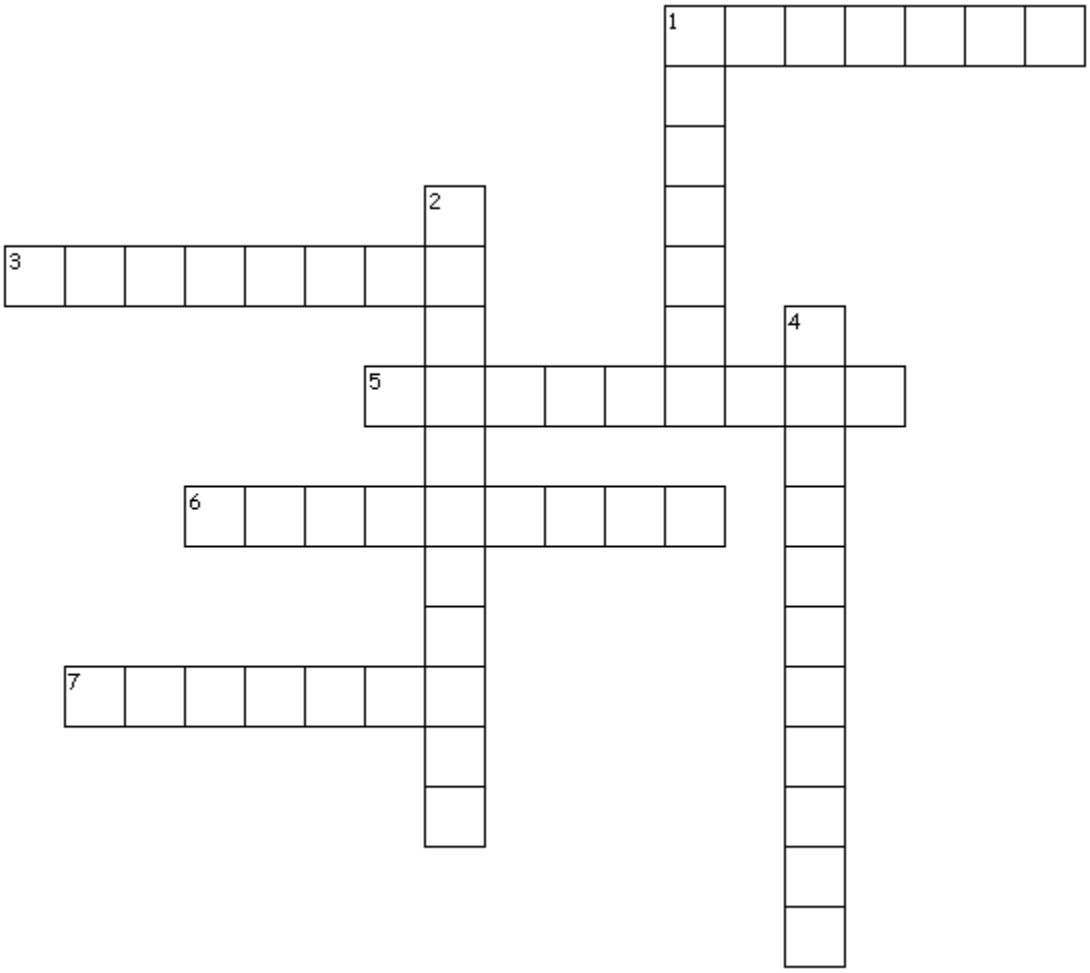
CIRCUIT
CONVERT
ELECTRICITY
ELECTRONS
GENERATORS
INTERRUPTED
PROVIDE
VERSATILE

# Solution

```
+ + + + D + + C + + + + + + S
+ + + + + E I + + + + + + + R
Y T I C I R T C E L E + + + O
+ + + + C + + P + + + + + + T
+ + + U + + + + U E + + + + A
+ + I + + + + C L R + + + + R
P T + + + + + I O + R + + + E
R + E L E C T R O N S E + + N
O + + + + A + + + + V + T + E
V + + + S + + + + + + + E + N G
I + + R + + + + + + + + + R + I
D + E + + + + + + + + + + + T +
E V + + + + + + + + + + + + + +
+ + + + + + + + + + + + + + + +
+ + + + + + + + + + + + + + + +
```

```
(Over,Down,Direction)
CIRCUIT(8,1,SW)
CONVERT(8,6,SE)
ELECTRICITY(11,3,W)
ELECTRONS(3,8,E)
GENERATORS(15,10,N)
INTERRUPTED(15,11,NW)
PROVIDE(1,7,S)
VERSATILE(2,13,NE)
```

# Circuits Crossword

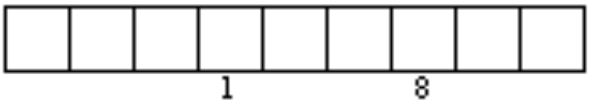



Across
1. the complete path of an electric
3. a very small particle that has a negative charge
5. having many uses
6. a machine for producing electric current
7. to change from one form to another

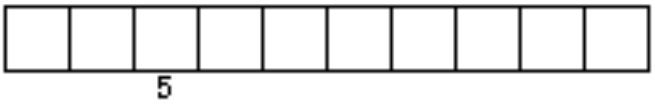
Down
1. a flow of electrons
2. to stop or hinder by breaking in
4. it powers light bulbs, TV's, etc.

# Circuits Double Puzzle

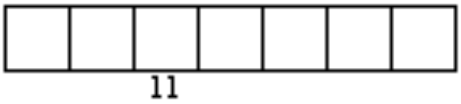
SELIATERV



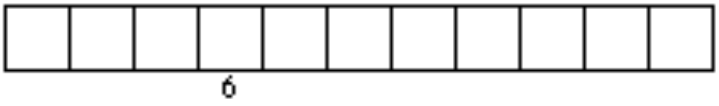

GESROARENT



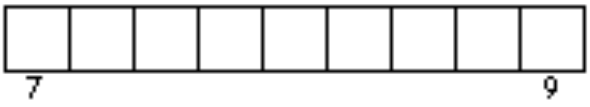

ROCVENT



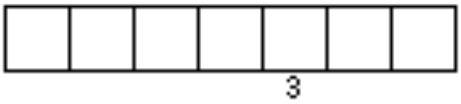

LECCEYTIRTI



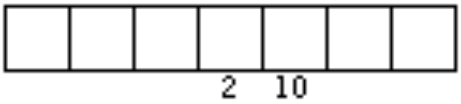

TEOCENSLR



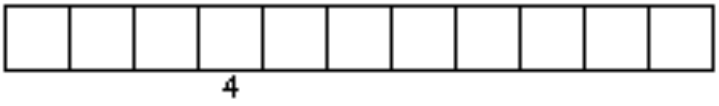

DIEROPV

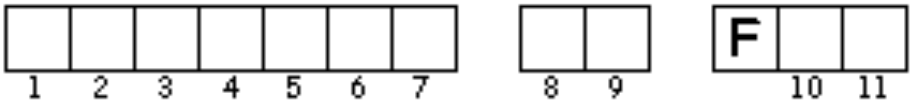



TICRUIC

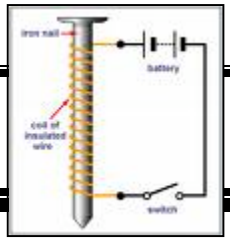



IUDERTEPTNR




Unscramble each of the clue words.
Copy the letters in the numbered cells to other cells with the same number.




# Electromagnetism

**Objective**

We will experiment by building and measuring the relative strength of an electromagnet.

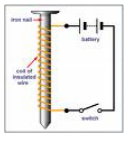
**Science Background**

Electricity and **magnetism** are closely **related**. In 1831, a scientist by the name of Michael Faraday began a **series** of experiments dealing with electricity. He found that when a magnet was moved close to a coil of wire, it would make electricity flow, without a battery. He soon discovered that the opposite was also true, that when electricity flowed through a coil of wire, it could attract a magnet. He is **considered** one of the best **experimentalists** in science. He enjoyed science and continued to experiment his entire life.

During his experiments, he created the world's first electric motor, using an electromagnet. Though Faraday **lacked** a **formal** education, his **contributions** to science were very important. Later scientists, such as James Clerk Maxwell would build on his research to understand light, electricity, and magnetism. Science will always continue to grow with each exciting discovery.

You will be reading a book to learn more about electromagnetism, then you will build and test your own simple motor!





# READING

**Discussion**: What do you know about electricity and magnets?

**Prediction**: You will learn about how electricity and magnetism and make a simple motor using those principles. What do you think your book will be about?

**Book List**:

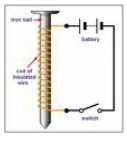
Amazing Magnetism (Magic School Bus Chapter Book) ISBN: 0439314321
Rebecca Carmi
Reading Level: 4.4
AR Points: 1

Electricity & Magnetism ISBN: 1-56847-460-1
Maria Gordon
Reading Level: 3.6
AR Points: 0.5

Electricity and Magnetism ISBN: 0-8172-3957-X
Terry Jennings
Reading Level: 3.9
AR Points: 0.5

**Summary**: How would you summarize your book for another student? Would you recommend it? Why or why not?





# Reading Comprehension Questions

Book Title: _____

Was your book fiction or non-fiction?_____

**Fiction Comprehension Questions**

1. Who is the main character of the story? _____

_____

_____

2. Can you describe the setting? _____

_____

_____

3. What is the main idea of the story? _____

_____

_____

**Non-fiction Comprehension Questions**

1. What is the main idea of the book? _____

_____

_____

2. What is the author's purpose for writing the book? _____

_____

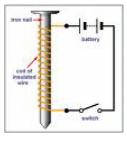
_____

3. List three pieces of information that you have learned from your reading.

_____

_____





# VOCABULARY

Magnetism - _____

_____

_____

Related - _____

_____

_____

Series - _____

_____

_____

Considered - _____

_____

_____

Experimentalist - _____

_____

_____

Lacked - _____

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_____

Formal - _____

_____

_____

Contributions - _____

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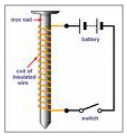
_____





# Electromagnets

**Hypothesis:** What do you think will happen if you remove the magnet from the motor? Will the wire still turn?

**Materials:** World's Simplest Motor Kit, 9 V battery, paper clips.

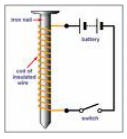
**Procedure:**

1. Put together the World's Simplest Motor, make sure the wire spins.
2. Now try the following:
    A. Cover up or take out the magnet.
    B. Take out the battery.
    C. Cover up or take out the magnet and try to pick up some paperclips with the wire.

**Conclusion:**

1. Does the wire stop spinning once you cover up or take out the magnet?
2. Does it stop spinning if you take out the battery?
3. Do you need both the magnet and the battery to make the motor work?
4. If you cover up the magnet can you use the wire to pick up paper clips?
5. What do you think happened to the wire?





# Teacher Resources

**On-line:**
Wikipedia: http://en.wikipedia.org/wiki/Electric_motor
How Stuff Works: http://electronics.howstuffworks.com/motor4.htm
Magnet Man: http://www.coolmagnetman.com/magelect.htm

**Materials:**

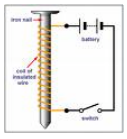
**Suggestions:**

1. Take apart a tiny electromagnetic motor and find the magnets and wire inside.
2. Show students how a speaker works, or build a simple one as directed on the above Magnet Man website.

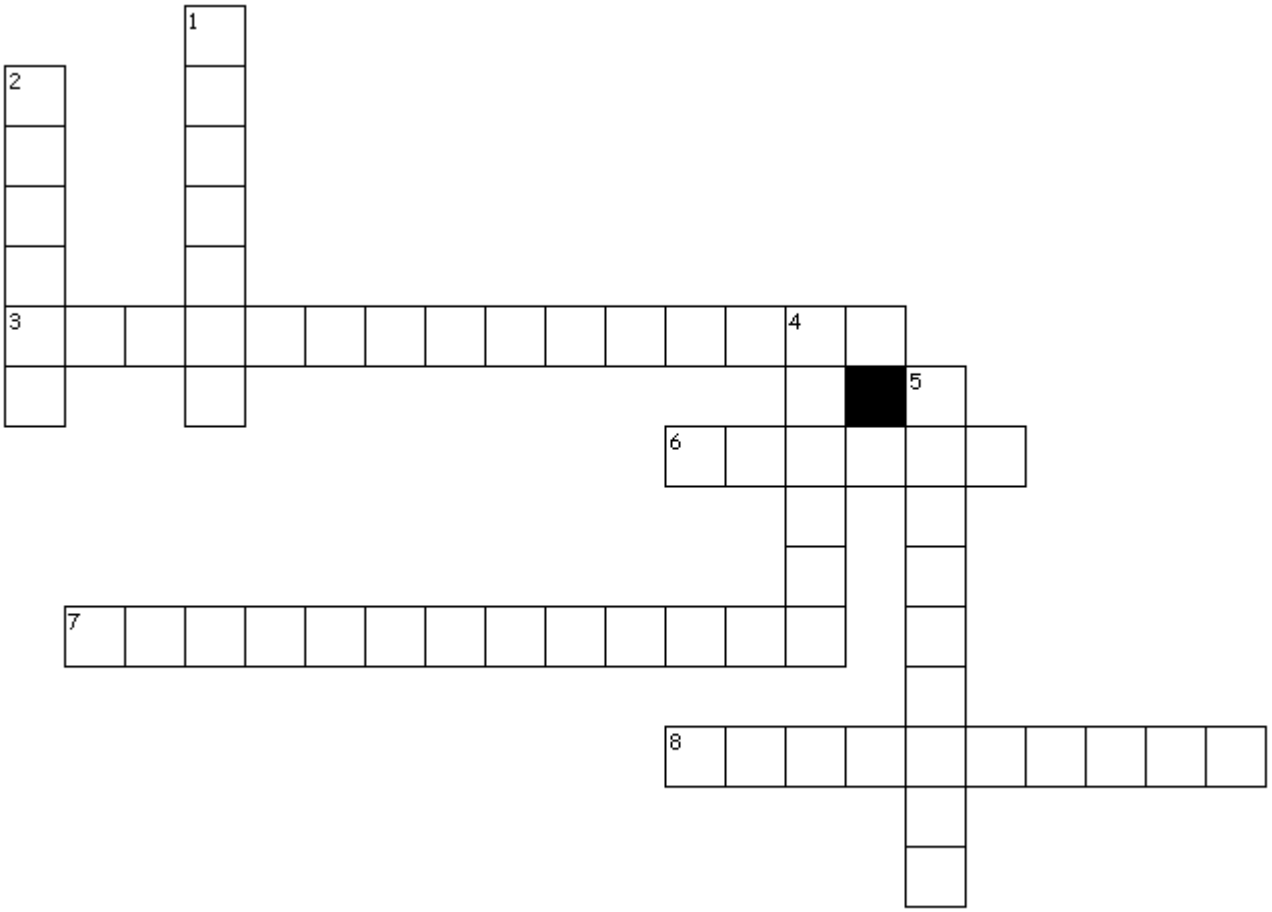
**Standards (see appendix A for detailed overview):**

**Physical Science 3 c)** - Electricity in circuits can produce light, heat, sound, and magnetic effects. Electrical circuits require a complete loop through which an electrical current can pass.





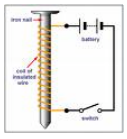
# Electromagnetism Cross Word




Across
3. someone who does experiments
6. following established form, custom or rule
7. the thing contributed or given to others
8. to think over carefully

Down
1. to show or have a relationship to or between: connect
2. something that is absent or needed
4. a number of things or events arranged in order and connected by being alike in some way
5. the power to attract that a magnet has



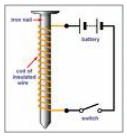


# Electromagnetism Word Search

S A Z C P F R Y J M D H L W V
S N Z Y O I B M V R E O A Y Y
S Y O R Z Y K M X V R Z C N V
H E M I I P K F M O E Y K I U
A A R F T A U S F I D V E D E
L V L I T U I V I Q I R D B A
W I I V E T B S C H S O D F A
I D U B E S G I O D N E K L K
W E F N J P K J R L O V K L E
X S G D P J J P I T C I J D J
M A R E L A T E D J N D Q X O
M F M L B N L F D L K O H C M
A T C J Z C L N G N Z P C T V
Y N Z J Q L M M X G P T K E T
T S I L A T M E I R E P X E X

CONSIDERED
CONTRIBUTIONS
EXPERIEMTALIST
FORMAL
LACKED
MAGNETISM
RELATED
SERIES



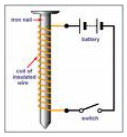


# Solution

```
S + + + + F + + + + D + L + +
+ N + + O + + + + + E + A + +
S + O R + + + + + + R + C + +
+ E M I + + + + M + E + K + +
+ A R + T + + S + + D + E + +
L + + I + U I + + + I + D + +
+ + + + E T B + + + S + + + +
+ + + + E S + I + + N + + + +
+ + + N + + + + R + O + + + +
+ + G + + + + + + T C + + + +
+ A R E L A T E D + N + + + +
M + + + + + + + + + + O + + +
+ + + + + + + + + + + + C + +
+ + + + + + + + + + + + + + +
T S I L A T M E I R E P X E +
```

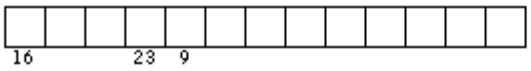
(Over,Down,Direction)
CONSIDERED(11,10,N)
CONTRIBUTIONS(13,13,NW)
EXPERIEMTALIST(14,15,W)
FORMAL(6,1,SW)
LACKED(13,1,S)
MAGNETISM(1,12,NE)
RELATED(3,11,E)
SERIES(1,3,SE)



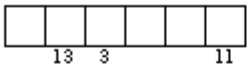


# Electromagnetism Double Puzzle

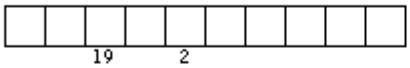
BIRTITSOONUNC




KADCEL

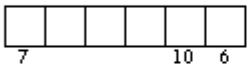



DINDOCSEER

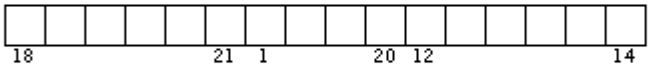



TERDALE

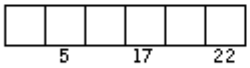

FARMOL



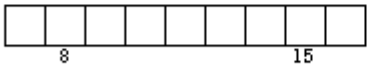

TESMNEXRISTALPIE




SEESIR

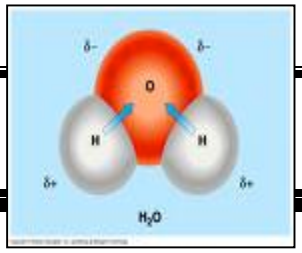



MENITMASG





Unscramble each of the clue words.
Copy the letters in the numbered cells to other cells with the same number.




# Electrolysis

**Objective**

We will learn how to separate Hydrogen from water by using the electrical current from a battery.

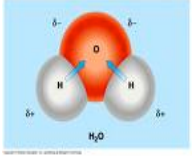
**Science Background**

Water is made up of tiny particles called **atoms**. The atoms that make up water two atoms of Hydrogen and one atom of Oxygen. Atoms are the smallest elements in the universe, and **combine** to form everything in the **universe**, from water to this paper to you! The atomic formula for water is $H_2O$, meaning two parts hydrogen and one part oxygen. Hydrogen is highly **flammable**, and is a main element in gasoline. Oxygen is a major **element** in the air, and is what our bodies need when we breathe in. When pure Hydrogen is burned, it combines with Oxygen from the air to form water.

Doing the **reverse** process, turning water into Hydrogen gas ($H_2$) and Oxygen gas ($O_2$) is called **electrolysis**. It takes energy to split water into Hydrogen and Oxygen, and this energy comes from electricity. When electricity passes from the negative **terminal** of the battery through the water and back to the positive terminal, it creates bubbles of Hydrogen and Oxygen gas. Remember, electricity must always flow in a complete path, called a circuit.

You will be reading more about Hydrogen and water, and the important roles they play on our planet, then you will perform your own electrolysis experiment and observe what happens!





# Reading

**Discussion:** When Hydrogen is combined with Oxygen, it produces water. What do you know about combining two things to make something new?

**Prediction:** Hydrogen is one of the most abundant elements on Earth. Hydrogen is found everywhere on Earth but rarely by itself. What do you think your book will be about?

**Book List:**

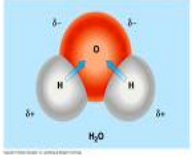
Hydrogen And The Noble Gases ISBN: 0-516-27849-5
Salvatore Tocci
Grade Level: 6
AR Points: 0.5

Water Everywhere ISBN: 9780756625320
DK Publishing
Grade Level: Ages 4 - 8
AR Points:

Water ISBN: 9780756625627
DK Publishing
Grade Level: Ages 9 - 12
AR Points:

**Summary:** How would you summarize your book for another student? Would you recommend it? Why or why not?





# Reading Comprehension Questions

Book Title: _____

Was your book fiction or non-fiction?_____

**Fiction Comprehension Questions**

1. Who is the main character of the story? _____

_____

_____

2. Can you describe the setting? _____

_____

_____

3. What is the main idea of the story? _____

_____

_____

**Non-fiction Comprehension Questions**

1. What is the main idea of the book? _____

_____

_____

2. What is the author's purpose for writing the book? _____

_____

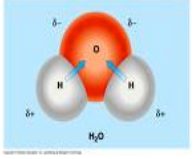
_____

3. List three pieces of information that you have learned from your reading.

_____

_____





# Vocabulary

Atoms - _____

_____

_____

Combine - _____

_____

_____

Universe - _____

_____

_____

Flammable - _____

_____

_____

Element - _____

_____

_____

Reverse - _____

_____

_____

Electrolysis - _____

_____

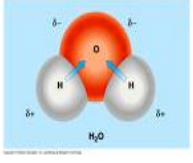
_____

Terminal -

_____

_____

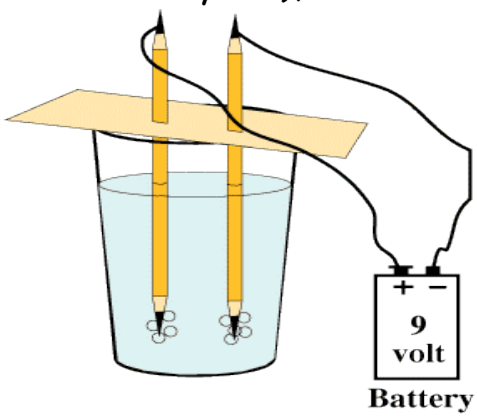




# Splitting Water

**Hypothesis:** Will more Hydrogen or Oxygen be produced from water?

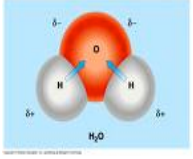
**Materials:** 9 V Battery, 2 wires (use the white wires from the EnviroBattery Kit), Pencil Lead, Clear Plastic Cup (From EnviroBattery Kit), Warm Water, 4" x 2" Piece of Cardboard (can also use construction paper), Small Salt Packet




**Procedure:**

1. Fill the clear plastic cup with warm water about 1/2-inch from the top.
2. Wrap one end of wire around one of the leads, and repeat with the other. Use masking table to secure the wire in place. Be sure to make a good connection with the lead these will be your electrodes.
3. Poke two holes in your cardboard using scissors. Push each lead piece half way through two holes about 1-inch apart about in the center of the cardboard. If the lead is slipping use tape to hold it in place.
4. Place the cardboard with the wires over the **top** of the plastic cup making sure that the tips in the water aren't touching the bottom of the cup or each other.
5. Now attach the free end of one of the wires to the nub of the battery with a "**–**" sign next to it. You can wrap the wire around the nub or just place it on top and tape it in place.
6. Take the other "free" wire and attach it to the nub with a "**+**" sign next to it. Tape it in place on top of the nubMake observations of what happens.
7. Now add the salt (about 1 teaspoon) to the water and stir until it dissolves. The salt will help the electric current from the battery move through the water. Again, make observations of what occurs at the tips of the lead.

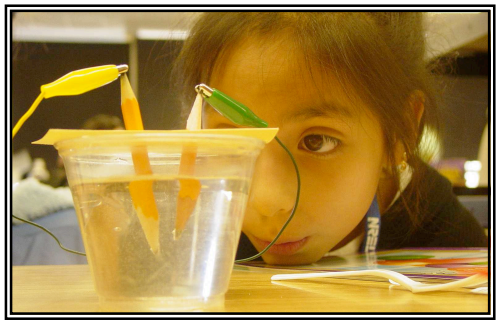




8. Make observations of the bubbles on the lead connected to the positive terminal of the battery, and on the negative lead.

**Data:**

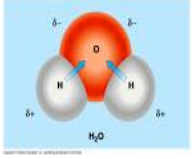
| | Observations |
|---|---|
| Water before salt | |
| Water after salt | |
| Bubbles on positive terminal | |
| Bubbles on negative terminal | |



**Conclusions:**

1. Why didn't any bubbles appear at step 5?
2. Did more bubbles form around the positive or the negative pencil?
3. Since Hydrogen is positively charged, will it be attracted to the positive or negative pencil?
4. Will more Hydrogen or Oxygen be produced from water?
5. Was your hypothesis correct?





# Teacher Resources

**On-line:**
Wikipedia: http://en.wikipedia.org/wiki/Electrolysis
US Department of Energy:
http://www1.eere.energy.gov/hydrogenandfuelcells
New Mexico Solar Energy Association:
http://www.nmsea.org/Curriculum/7_12/electrolysis/electrolysis.htm

**Materials:**

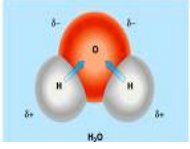
The pencil lead isn't really necessary beyond providing a good point source for the bubbles to form on. They also make easy to manipulate leads to place in the water. The experiment will run if the wires are placed directly in the salt-water solution, and bubbles will form the hole length of the bare wires in solution.

The chemical formula for salt is NaCl. Sodium (Na) is very positive, while Chlorine (Cl) is very negative. The salt splits into these ions very easily, which allows electricity to flow through the water much more easily. More electricity means more bubbles.

**Suggestions:**

1. Capture both gasses in two small test tubes and perform a splint test. Placing a barely burning match, or splint, into the test tube with each gas can distinguish between hydrogen and oxygen. You should hear a small popping sound or even see the gas ignite in the flammable Hydrogen. The splint will burn more brightly when placed in the fire-fueling Oxygen.
2. Make a little bubble bridge. Fold a small piece of transparency in a "V" shape, and use this to catch bubbles and watch them run uphill. This can make observations of the amount of bubbles coming off each terminal easier to determine.
3. Experiment qualitatively with different levels of salt in the water. Allow students to observe a few different cups with levels of salt varying from none to as much as can be dissolved.

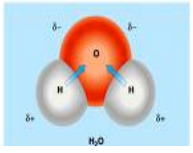




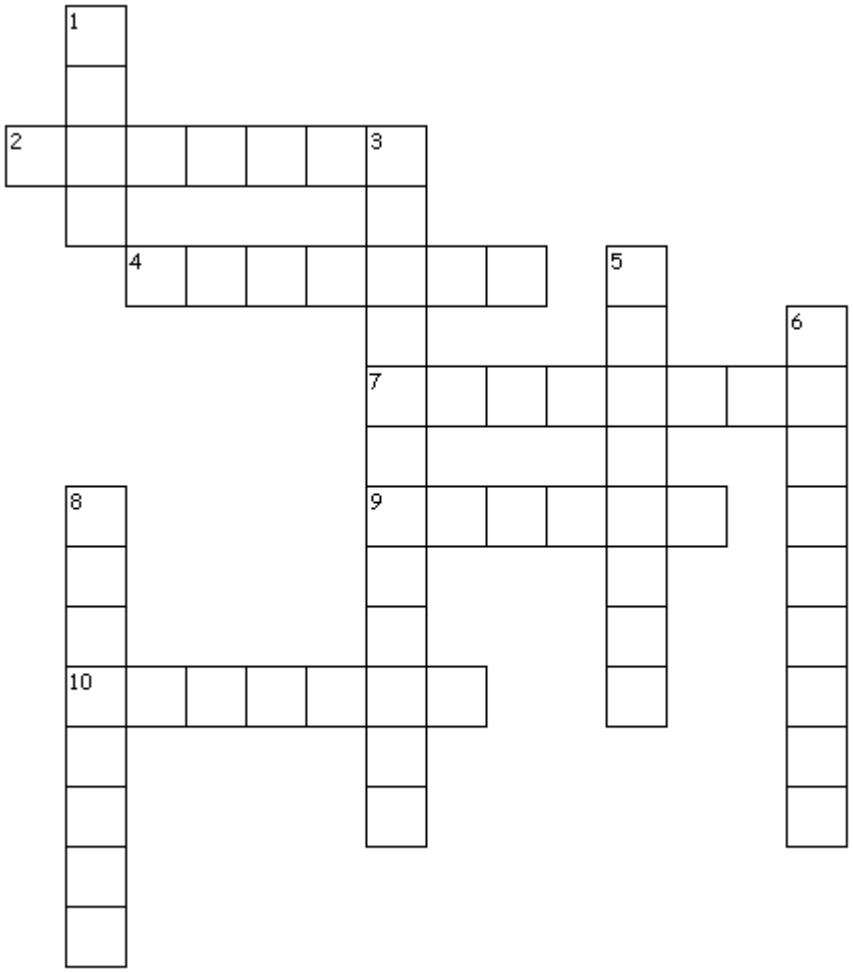
**Standards (see appendix A for detailed overview):**

**Physical Science 1 b)** - Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.





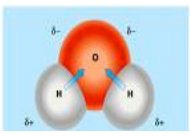
# Electrolysis Crossword




Across
2. to join together so as to make one thing
4. a substance that cannot be separated into different substances
7. a device at the end of a wire for making an electrical connection
9. what our bodies need when we breathe in air
10. to go or cause to go in the opposite direction

Down
1. the smallest elements in the universe
3. the act of turning water into Hydrogen and Oxygen using electricity
5. all created things including the earth and everything in space
6. easily set on fire
8. the most abundant element in the universe





# Electrolysis Word Jumble

MOTSA _____ (9)

MANLRTEI _____ (3)

CTRILSEESLYO _____ (6, 8)

DYONEHRG _____ (4)

SEEVERR _____ (7)

LENMETE _____ (5, 14)

GYOXEN _____ (10)

MONCEBI _____ (2)

REENUISV _____ (11, 1)

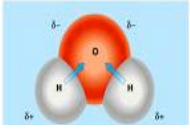
FAMLALEBM _____ (13, 12)

_____ _____ _____ !

1 2 3 4 5 6 7 | 8 9 | 10 11 12 13 14

Unscramble each of the clue words.
Copy the letters in the numbered cells to other cells with the same number.



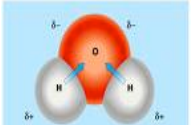


# Electrolysis Word Search

F H I E L E C T R O L Y S I S
E L C G A S N E K I F G X V H
A S A S W E B R P Y T Q K Y H
O T R M M A A M J U B B D B N
T M O E M I J I O D N R T R L
B F L M V A R N R W O F L G T
B E J C S E B A M G F P W E L
E U O K Y Y R L E G Y Y Q K A
N C G X B V S N E W H C L G R
I K I I K W J J F T Z Z G D E
B F D Z P I A E X J I Z I O L
M Y V I R Q W E P Y C F M N W
O L D M E B E S R E V I N U Y
C K T Y B J K M W P W W X D K
D V R E W P V P B O X Y G E N

ATOMS
COMBINE
ELECTROLYSIS
ELEMENT
FLAMMABLE
HYDROGEN
OXYGEN
REVERSE
TERMINAL
UNIVERSE



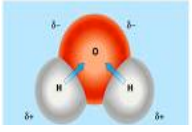


# Electrolysis Solution

```
F + + E L E C T R O L Y S I S
E L + + + + N E + + + + + + H
A S A + + E + R + + + + + Y +
+ T R M M + + M + + + + D + +
+ + O E M + + I + + + R + + +
+ + L M V A + N + + O + + + +
+ E + + S E B A + G + + + + +
E + + + + + R L E + + + + + +
N + + + + + + N E + + + + + +
I + + + + + + + + + + + + + +
B + + + + + + + + + + + + + +
M + + + + + + + + + + + + + +
O + + + + + E S R E V I N U +
C + + + + + + + + + + + + + +
+ + + + + + + + + O X Y G E N
```

(Over,Down,Direction)
ATOMS(1,3,SE)
COMBINE(1,14,N)
ELECTROLYSIS(4,1,E)
ELEMENT(2,7,NE)
FLAMMABLE(1,1,SE)
HYDROGEN(15,2,SW)
OXYGEN(10,15,E)
REVERSE(7,8,NW)
TERMINAL(8,1,S)
UNIVERSE(14,13,W)





# Biomass

**Science Background**

The sun is the **origin** of almost all energy on our planet. Plants get their energy directly from the sun in a **process** called **photosynthesis**. Plants can store this energy in fruits and vegetables. We take the energy from the plants when we eat their fruit. When we eat hamburgers, we get the energy that the cow was storing from eating grasses, which were storing energy from the sun.

**Biomass** is the material of any living, or **recently** living **organism**. Trees, animals, crops, wood, and animal wastes are all **classified** as biomass. Biomass has been our **primary** source of energy for thousands of years. We have burned wood for energy to heat our homes and cook our food and make light in the dark. Only in the last 150 years have we started using other energy sources such as coal, wind, or nuclear power.



# Reading

**Discussion**: Anything that is alive or was once alive is called Biomass. People and animals get their energy from biomass when they consume fruits, vegetables and any part of a plant. What do you know about biomass? What are some sources for biomass energy?

**Prediction**: Biomass energy is renewable because new plants and trees can be produced. The sun's energy that is stored in plants can also be used to produce electricity. What do you think your book will be about?

**Book List:**

The Big Tree — ISBN: 0689315988
Bruce Hiscock
Grade Level: 5.2
AR Points: 0.5

The Giving Tree — ISBN: 0060256656
Shel Silverstein
Grade Level: 2.6
AR Points: 0.5

The Great Kapok Tree — ISBN: 0152026142
Lynne Cherry
Grade Level: 3.8
AR Points: 0.5

**Summary:** How would you summarize your book for another student? Would you recommend it? Why or why not?



# Reading Comprehension Questions

Book Title: _____

Was your book fiction or non-fiction?_____

**Fiction Comprehension Questions**

1. Who is the main character of the story? _____

_____

_____

2. Can you describe the setting? _____

_____

_____

3. What is the main idea of the story? _____

_____

_____

**Non-fiction Comprehension Questions**

1. What is the main idea of the book? _____

_____

_____

2. What is the author's purpose for writing the book? _____

_____

_____

3. List three pieces of information that you have learned from your reading.

_____

_____



# VOCABULARY

Origin - _____

_____

_____

Process - _____

_____

_____

Photosynthesis - _____

_____

_____

Biomass - _____

_____

_____

Recently - _____

_____

_____

Organism - _____

_____

_____

Classified - _____

_____

_____

Primary - _____

_____

_____



# Potato Power

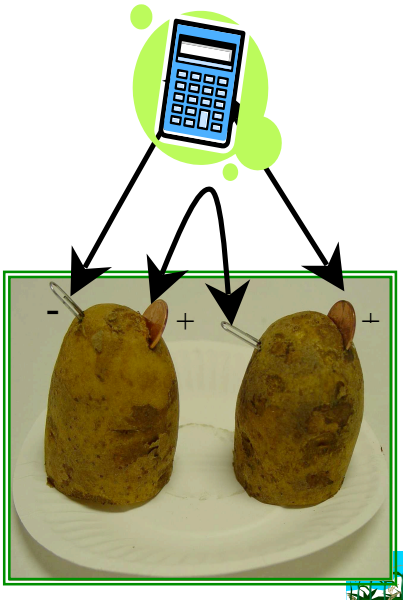
**Objective:** The students will learn how the sun's energy is stored in food and plants as biomass can be converted into electricity.

**Hypothesis:** How many potatoes does it take to light a light bulb?

**Materials:** one potato, one EnviroBattery Kit, (You can also use apples, oranges, etc.), paper plate, knife. Please keep all of the materials because you will use them again later.

**Procedure:**

1. Place a copper plate and a zinc plate into the potato.
2. Connect the led light (it is at the top of the gray tower) to the zinc and copper. To do this you need to connect the black wire to the zinc plate and the red wire to the copper plate.
3. Record if your light is dim or bright on the table below.
4. Remove the copper and zinc plates.
5. Now have your tutor help you to cut the potato in half.
6. Place the two potato halves face down on the paper plate. We will now create what is called a series.
7. Place a copper and zinc plate in each potato half.
8. Connect the outer copper and zinc plates with a connector wire (the white wire).
9. To the inner plates, attach (From the led light) the black wire to the zinc and the red wire to the copper.
10. Record if the light is on, and whether it's dimmer or brighter than one potato.
11. There is a great diagram of this in the



instruction book that came with your EnviroBattery.

12. Using the figure on page 5 of the instruction book and another student's potato half see if you can create a series with 3 potatoes. Then try 4. Record your results below.

**Data:**

| # of potato or potato halves | Light? |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |

**Conclusions:**

1. What is the potato being used as in this experiment?
2. What happened to the light as more potatoes were added?
3. Where did the energy from the potato come from?
4. How many potatoes does it take to light a light bulb?
5. Was your hypothesis correct?



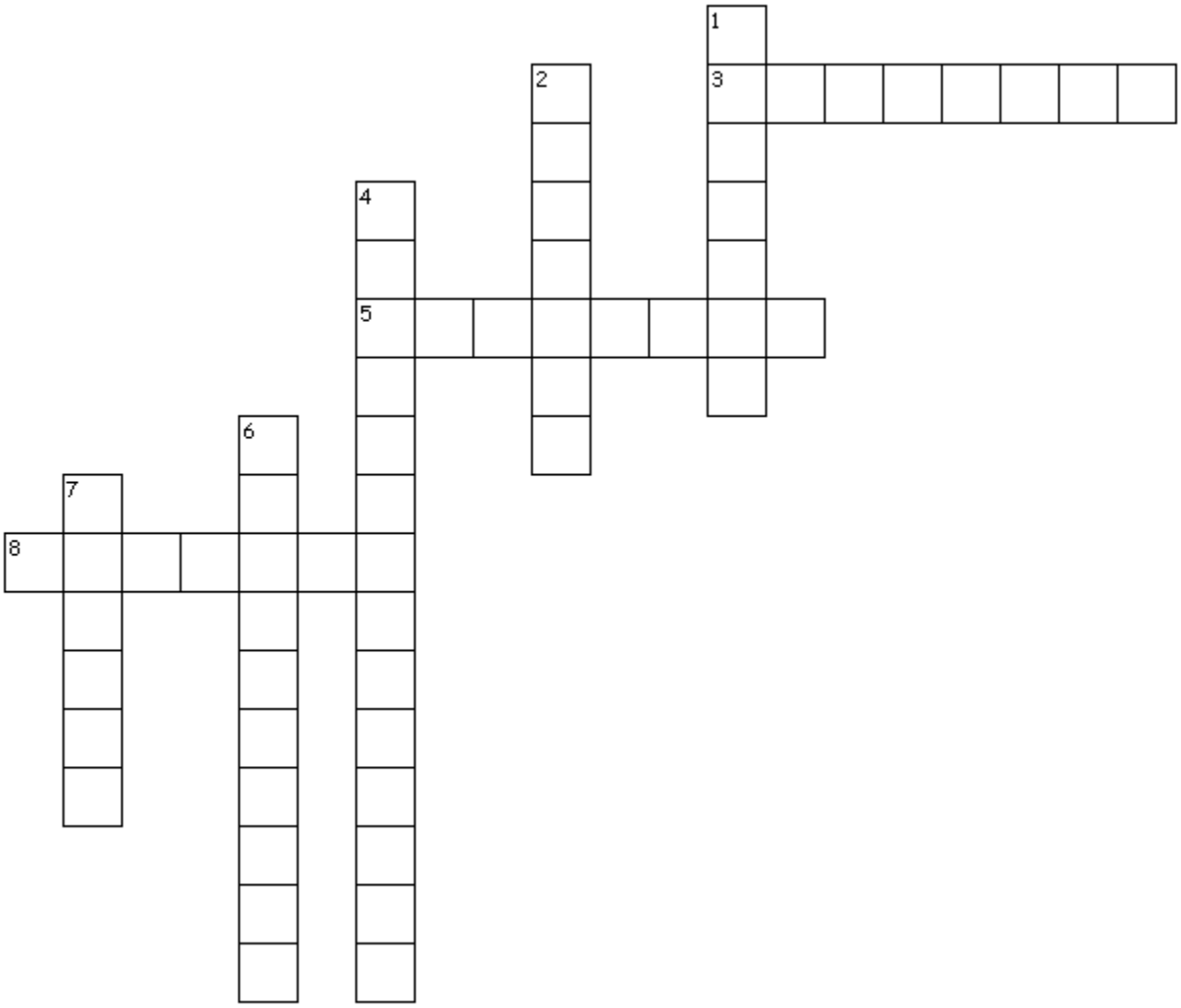
# Teacher Resources

**Suggestions:**

1. Biomass resources are renewable, but they are also finite. Consider the problems of deforestation in the Amazon. Here, just like with fossil fuels, people are using up their biomass resources faster than they can be replenished. Sustainability is an important factor for renewable resources. We must consider how fast we can regrow the resource before using it all up.
2. Try other fruits or vegetables to compare the electricity they produce. Acidic citrus, such as oranges or lemons will also work well.
3. Compare the light given off from the LED to that given off by a small incandescent light bulb. You should find that it takes much more energy to light an incandescent light than an LED. Incandescent light bulbs waste a lot of energy compared to other lighting options.



# Biomass Crossword




Across
3. fresh, new
5. a living being  able to carry on the activities of life, a person animal or plant
8. most important

Down
1. a series of actions, motions, or operations leading to some result
2. plant matter, that can be converted to fuel and is therefore regarded as a potential energy source
4. the process by which green plants form carbohydrates from carbon dioxide and water in the presence of light
6. to group or arrange



7. the beginning or the base source

# Biomass Word Jumble

RIMRAPY

LDSICFASIE

GIORIANMS

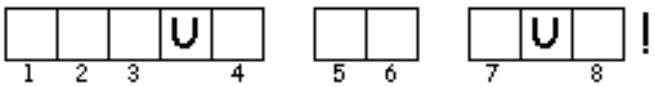
CENRYLTE

SIOBASM

SOESISHYTTNPOH

RINGIO

ORSESPC




Unscramble each of the clue words.
Copy the letters in the numbered cells to other cells with the same number



# Biomass Word Search

P Q Y Y B Q H O X O S K O C P
O H F R W N I Q R R S X Z L N
R L O Z A Y L G H K A X D A O
O T W T A M A S C R M D X S C
J L G Q O N I F V K O C B S Q
G H R I I S O R I G I N T I M
J Y H S V P Y Q P C B A K F I
X E I L V X A N R Z Y F F I K
D M Z I W G C X T S U Y X E W
Y L T N E C E R S H B X U D B
X F W L K B R E G P E U N Q V
C U O E I Q C R E K S S Z X N
N C G R R O F L T O E T I O I
U N N U R L M B D W G Y G S G
A C W P P R J O F A Y E Q H R

BIOMASS
CLASSIFIED
ORGANISIM
ORIGIN
PHOTOSYNTHESIS
PRIMARY
PROCESS
RECENTLY



# Biomass word search solution

```
P + Y + + + + + + O S + + C +
+ H + R + + + + R + S + + L +
+ + O + A + + G + + A + + A +
+ + + T + M A + + + M + + S +
+ + + + O N I + + + O + + S +
+ + + + I S O R I G I N + I +
+ + + S + + Y + P + B + + F +
+ + I + + + + N + + + + + I +
+ M + + + + + + T S + + + E +
Y L T N E C E R S H + + + D +
+ + + + + + + E + + E + + + +
+ + + + + + C + + + + S + + +
+ + + + + O + + + + + + I + +
+ + + + R + + + + + + + + S +
+ + + P + + + + + + + + + + +
```

(Over,Down,Direction)
BIOMASS(11,7,N)
CLASSIFIED(14,1,S)
ORGANISIM(10,1,SW)
ORIGIN(7,6,E)
PHOTOSYNTHESIS(1,1,SE)
PRIMARY(9,7,NW)
PROCESS(4,15,NE)
RECENTLY(8,10,W)



# Fermentation

**Science Background**

The process of **fermentation** has been used for thousands of years. However, scientists have only come to understand how it works in the last hundred years. In 1857, Louis Pasteur was the first scientist to **recognize** the **connection** between fermentation and an organism called **yeast**. Fermentation is the process that yeast uses to make the energy it needs to live. Yeast turns sugar into carbon dioxide and alcohol. Carbon dioxide is a gas that the yeast gives off. Alcohol is a liquid which has many possible uses, including fueling the cars of the **future**.

Ethanol is a type of alcohol that is given off by yeast. Many gas stations today are adding 10% ethanol to their gasoline. This **allows** the gas stations to save gas, and replace it with a renewable energy **resource** that still works in gasoline cars. Ethanol is renewable because it is produced by organisms that can be re-grown. There are cars today that run on ethanol instead of gasoline. They use a **fuel** that is 85% ethanol. This is called E85 and is sold just like gasoline at many gas stations.



# Reading

**Discussion**: Fossil fuels were created over millions of years, but are being used up faster than we can make more. We can always make more ethanol by growing more yeast. What do you know about yeast?

**Prediction**: Gasoline is made of fossil fuels, which will one day run out. New fuels like ethanol are renewable, which means they can last forever. What do you think your book will be about?

**Book List:**

What if We Run Out of Fossil Fuels? ISBN: 0516234781
Kimberly Miller
Grade Level: 5.5
AR Points: 1.0

Biomass: Fueling Change ISBN: 0778729281
Niki Walker
Grade Level: 7.4
AR Points: 1.0

Making Heart-bread ISBN: 0809167271
Sheila Fabricant Linn
Grade Level: Ages 9 - 12
AR Points:

**Summary**: How would you summarize your book for another student? Would you recommend it? Why or why not?



# Reading Comprehension Questions

Book Title: _____

Was your book fiction or non-fiction?_____

**Fiction Comprehension Questions**

1. Who is the main character of the story? _____

_____

_____

2. Can you describe the setting? _____

_____

_____

3. What is the main idea of the story? _____

_____

_____

**Non-fiction Comprehension Questions**

1. What is the main idea of the book? _____

_____

_____

2. What is the author's purpose for writing the book? _____

_____

_____

3. List three pieces of information that you have learned from your reading.

_____

_____



# VOCABULARY

Fermentation - _____

_____

_____

Recognize - _____

_____

_____

Connection - _____

_____

_____

Yeast - _____

_____

_____

Future - _____

_____

_____

Allows - _____

_____

_____

Resource - _____

_____

_____

Fuel - _____

_____

_____



# Fermentation

**Objective:** We will investigate the production of gasses from micro-organisms.

**Hypothesis:** Can microorganisms change one material to another?

**Materials:** cup, warm water, sugar, yeast

**Procedure:**

1. Begin with a sugar cube. Record 5 observations in your data.
2. Next break the sugar cube up into lots of little pieces.
3. Add warm temperature water and transfer the broken down sugar. Record 5 observations in your data.
4. Finally, add the organic material to the sugar water. Record 5 observations in your data.
5. Wait 10 minutes for the organic material to finish working. Record 5 final observations in your data.

**Data/Observations:**

1. 5 sugar cube observations
2. 5 sugar water observations
3. 5 organic material observations
4. 5 final observations

**Conclusion:**

1. What is a common use of yeast?
2. What happened to the sugar water after the yeast was added?
3. Draw a picture of the final mixture.
4. Can microorganisms change one material to another?
5. Was your hypothesis correct?



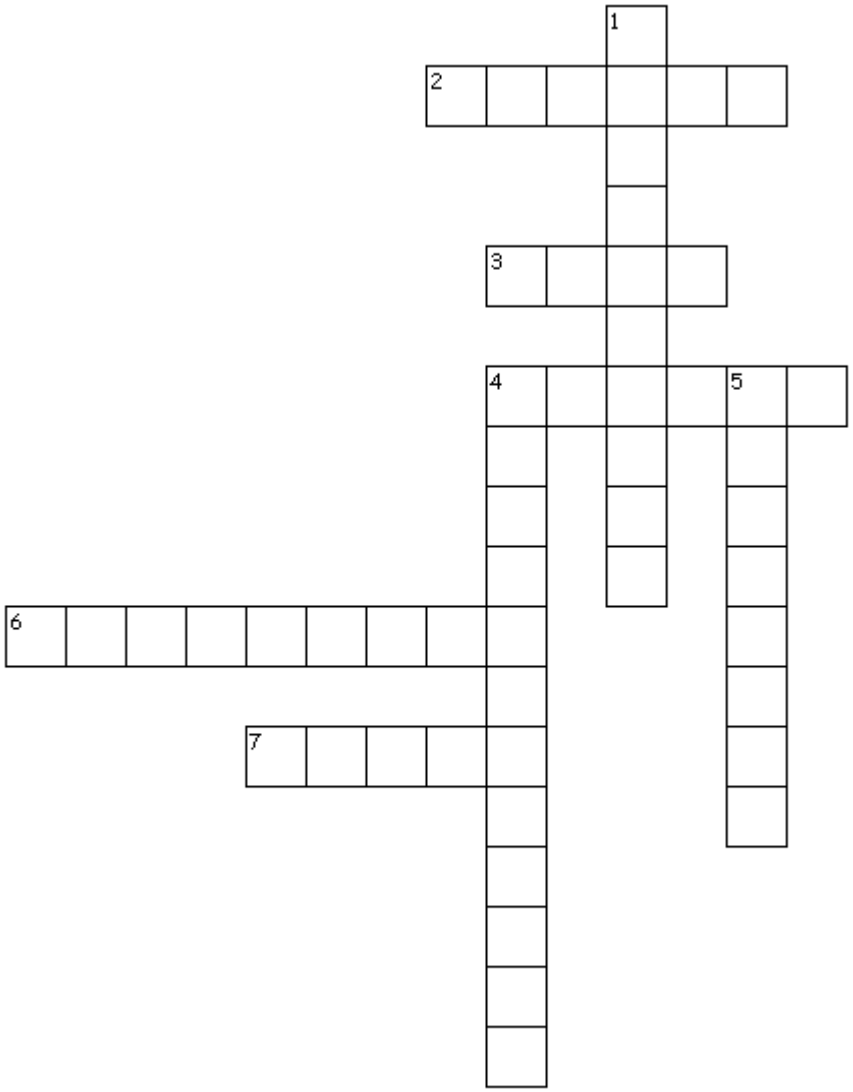
# Teacher Resources

**Suggestions:**

1. Students can do the fermentation process in a plastic soda bottle. A hole must be punched in the cap to allow the carbon dioxide gas to escape. A balloon can be stretched over the cap, then screwed onto the bottle, so that the gas actually inflates the balloon.
2. Use this experiment to describe how we convert sugars into energy. Sugars, and carbohydrates that can be broken down into sugars are the fuels our cells use. When these fuels are chemically burned with oxygen in our cells, they give of carbon dioxide. This explains why we must always take in oxygen, and then expel the carbon dioxide.
3. Discuss how yeast is used in cooking. Yeast is added to bread dough, so that as it cooks, the yeast gives off carbon dioxide and causes the bread to rise. Without yeast, our bread would be flat instead of fluffy.



# Future Fuels Crossword




Across
2. to give permission to
3. a substance that can be burned to produce heat or power
4. coming after the present
6. to be willing to accept
7. any group of tiny fungi that form alcohol or raise bread dough

Down
1. the act of bringing together in thought
4. a chemical breaking down of an organic material
5. a new reserve source of supply or support



# Future Fuels Double Puzzle

TETRIONEMNAF

ZEICONREG

OCITNONCEN

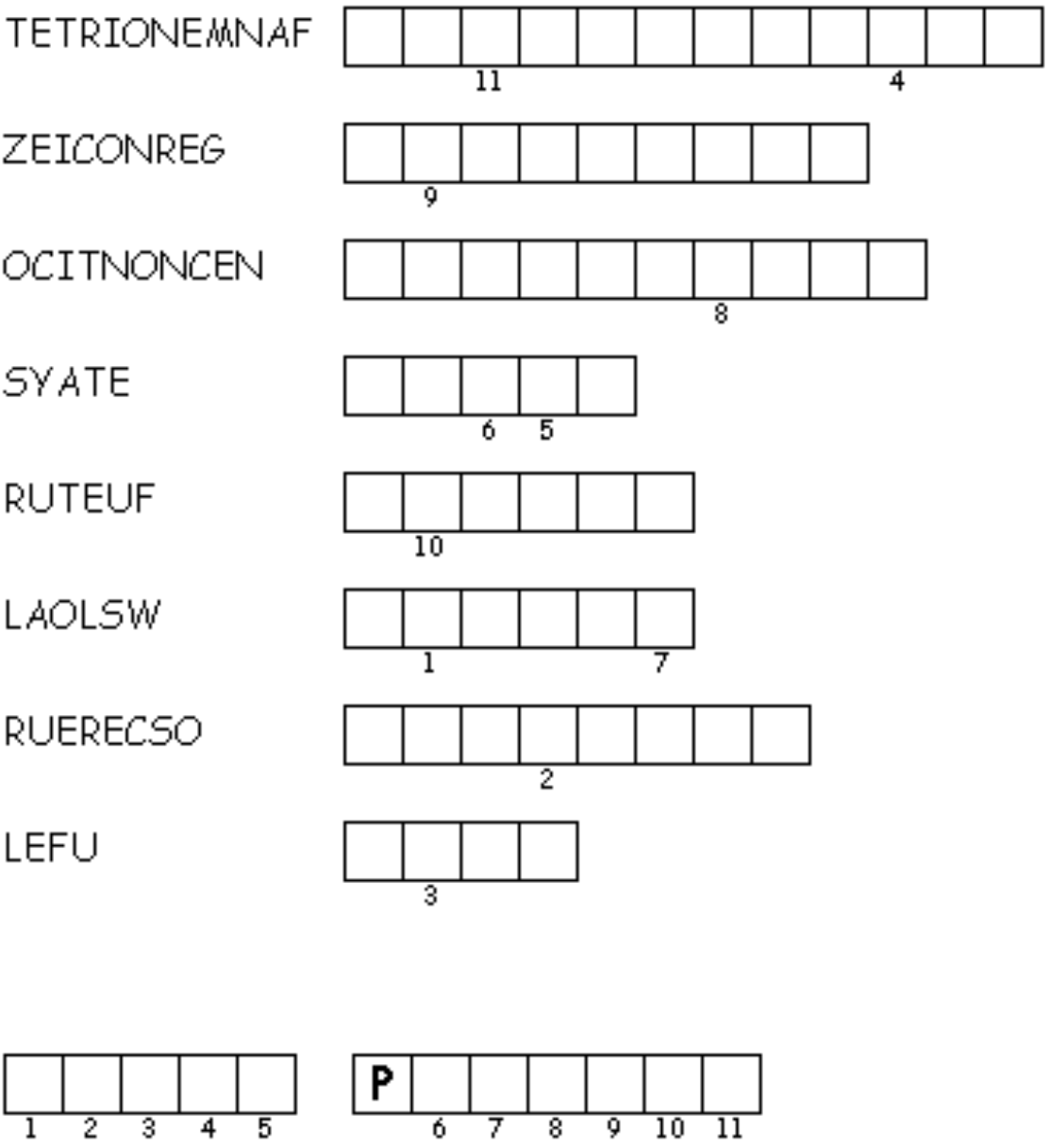
SYATE

RUTEUF

LAOLSW

RUERECSO

LEFU




Unscramble each of the clue words.
Copy the letters in the numbered cells to other cells with the same number.

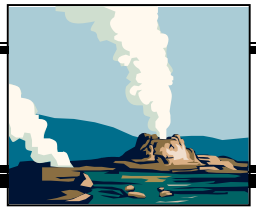


# Future Fuels Word Search

N R O N M X Z E E X E S Q E E
G O E J J Q C E X O Z B J H T
Q I I Q F R Z H E V I V C A T
W R F T U M Z P X A N M W B I
Y X A O C X X X C H G Z D F O
A G S L A E V B O X O B A D F
I E U F L B N X Z B C J P M E
R P M H L O V N X V E Y U B O
F U T U R E W E O C R E N D R
D T U C Z H H S L C O A D E M
M I D N D L S A Z X K S Z F B
S F M S P Z Z B J X X T F K I
E V S H U S Z U J X B U Z W L
N O I T A T N E M R E F P K X
Q I J Z A Q F F G L J E G N P

ALLOWS
CONNECTION
FERMENTATION
FUEL
FUTURE
RECOGNIZE
RESOURCE
YEAST





# Volcanoes

**Objectives**

We will earn more about the power held deep below the Earth's surface by creating a model volcano eruption.

**Science Background**

A **volcano** is the place where hot, liquid rock breaks through the Earth's crust. As the plates on the Earth's crust are moving, so is the **magma**, or melted rock inside the **mantle**. The magma rises up a main pipe and any branch pipes. Sometimes the magma finds a crack between the plates. When the magma reaches the top, it spills out of the hole called the crater. Now the magma is called **lava**.

There are two kinds of lava. One cools quickly from the volcano and as it cools, it turns into smooth rock. The other kind cools much more slowly. Sometimes it sprays out of the **crater** and hardens into sharp rocks and ash while in the air. The ash forms black clouds that can block out the sun and make it dark even during the middle of the day.

Volcanoes often **occur** at the edges of the Earth's crustal plates, Sometimes; volcanoes are formed when hot spots inside the mantle rise to the base of a plate. This is how the Hawaiian Islands were formed. A volcano that can **erupt** at any moment is called an active volcano. If a volcano has been quiet for many years but may erupt in the future, it is known as "sleeping" or dormant. An **extinct** volcano is one that is unlikely to erupt again like Mount Kilimanjaro in Africa.

You will be reading a book about volcanoes and then modeling your own volcanic eruption!



# READING

**Discussion:** Volcanoes are one of the most destructive forces on Earth. Eruptions can last days or even weeks. What do you know about volcanoes?

**Prediction:** Pressure deep within the Earth builds up over many years before finally being released in a volcanic explosion. The forces of volcanoes start deep within the Earth. What do you think your book will be about?

**Book List:**

Volcanoes: Mountains that Blow their Tops ISBN: 0448411431
Nicholas Nirgiotis
Grade Level: 2.7
AR Points: 0.5

The Magic School Bus: Inside the Earth ISBN: 0590407600
Joanna Cole
Grade Level: 3.6
AR Points: 0.5

Eruption - The Story of Volcanoes ISBN: 0789473615
Linda Martin
Grade Level: 4.0
AR Points: 0.5

**Summary:** How would you summarize your book for another student? Would you recommend it? Why or why not?



# Reading Comprehension Questions

Book Title: _____

Was your book fiction or non-fiction?_____

**Fiction Comprehension Questions**

1. Who is the main character of the story? _____

_____

_____

2. Can you describe the setting? _____

_____

_____

3. What is the main idea of the story? _____

_____

_____

**Non-fiction Comprehension Questions**

1. What is the main idea of the book? _____

_____

_____

2. What is the author's purpose for writing the book? _____

_____

_____

3. List three pieces of information that you have learned from your reading.

_____

_____



# Vocabulary

Volcano - _____

_____

_____

Magma - _____

_____

_____

Mantle - _____

_____

_____

Crater - _____

_____

_____

Occur - _____

_____

_____

Erupt - _____

_____

_____

Extinct - _____

_____

_____



# Modeling Volcanoes

**Hypothesis:** How does a volcano work?

**Materials:** Funnel, 16-ounce plastic bottle (preferably a clear soda), mentos, Red food coloring, Cake pan, Soil and sand, Red, yellow, orange tissue paper, Black construction paper

**Procedure:**

1. Form a mountain by making a cone from the black construction paper and gluing the ends together. This should be placed on top of the pie pan with a large enough opening to put the soda bottle.
2. Cut and glue red, orange, and yellow tissue paper to the top of the mountain to represent an erupting volcano.
3. Add red food dye to the soda and place it in the center of the volcano.
4. Create a mountain with soil and sand around the bottle.
5. Quickly drop the mentos into the plastic bottle through the funnel and then remove the funnel.

**Data:** (Completed model volcano)

**Conclusions:**

1. What happened to your volcano after adding the mentos?
2. What causes the pressure to increase enough to erupt?
3. Give three similarities between this volcano and a real one.
4. How does a volcano work?
5. Was your hypothesis correct?



# Teacher Resources

**On-line:**
Wikipedia: http://en.wikipedia.org/wiki/Volcano
Geothermal Education Office: http://geothermal.marin.org/
NREL: http://www.nrel.gov/learning/re_geothermal.html

**Materials:**

The mentos textured surface promotes carbon dioxide bubbles from the soda to form. As more and more carbon dioxide forms, it quickly bubbles over in an explosive reaction. This is similar to the process of shaking a can of soda. The shaking allows more carbon dioxide to bubble out of the soda, and when the can is opened, these bubbles are able to expand, pushing soda up and out of the container.

Diet soda has been reported to erupt better, and it has the added benefit of having less sugar, and therefore less sticky cleanup. Don't attempt this experiment indoors, since cleaning soda off of ceiling tiles can be a regrettable experience.

A geyser tube can be purchased that greatly simplifies the "drop and run" mentos procedure. It screws onto the top of a soda bottle and contains a pin, that when pulled, drops a cargo of mentos straight into the soda.

**Suggestions:**

1. A large volcano, and impressive demonstration, can be created by using a liter of soda with a pack of mentos. Remember, this should be done outside, preferably somewhere you don't have to clean up.
2. Real volcanoes occur because of an increase in pressure that comes from increasing temperature or melted rocks releasing gasses. These can build up greatly before a massive volcanic explosion. The effect of temperature on pressure can be modeled by putting room temperature water in a bottle and sealing a balloon over the top. Put the bottle in boiling water, and as

the water inside the bottle heats up, the balloon will expand. Put the bottle in ice water and watch the bottle be sucked into the bottle.

3. Discuss the various eruptions and geysers that happen on other planets. What are these caused by and how are they similar or different than what happens on Earth. Mars is thought to have active volcanoes, and there are incredible eruptions on Io, a moon of Jupiter.

**Standards (see appendix A for detailed overview):**

**Physical Science 1 b)** - Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.

# Volcano Word Search

C T S O D K R I Z R R U W L K
Z L C M C E M A G M A E I M P
L O Q N T C S K Z S S R Z T A
D U D A I N U T A R O U A I J
V J R B J T U R B M R P A X R
M C C U C D X M T A A T Y D U
O N A C L O V E H Y A K U O Z
N R G Y P U K L O D M P K M U
O Y S T C J Q T X J S G D K M
N W X G A H C N O I W I I D I
F A R P Q B M A R L B M X H A
K Y A R C B F M Q V K C N T C
U J X W R D H U G X Z E X Q Y
B G W S O N E Q P I D Y D M N
O G J N X R H N T P E A X R Q

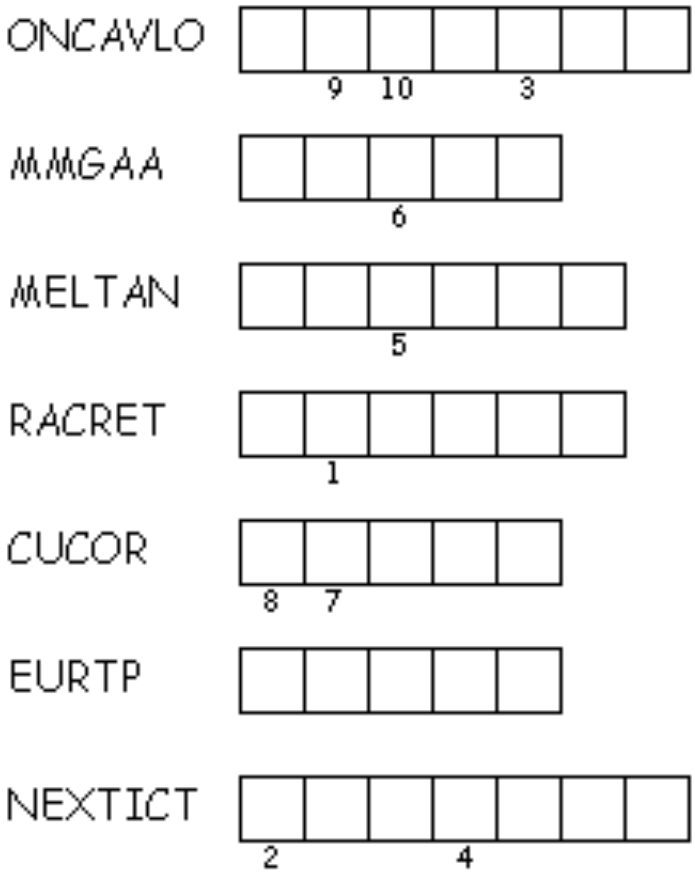
CRATER
ERUPT
EXTINCT
MAGMA
MANTLE
OCCUR
VOLCANO

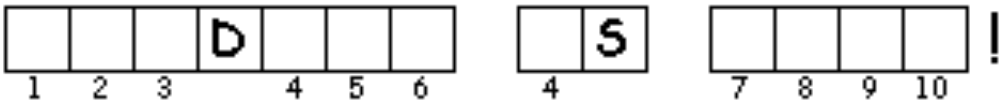
# Solution

```
+ T + O + + R + + + + + + + + +
+ + C + C E M A G M A E + + +
+ + + N T C + + + + + R + + +
+ + + A I + U + + + + U + + +
+ + R + + T + R + + + P + + +
+ C + + + + X + + + + T + + +
O N A C L O V E + + + + + + +
+ + + + + + + L + + + + + + +
+ + + + + + + T + + + + + + +
+ + + + + + + N + + + + + + +
+ + + + + + + A + + + + + + +
+ + + + + + + M + + + + + + +
+ + + + + + + + + + + + + + +
+ + + + + + + + + + + + + + +
+ + + + + + + + + + + + + + +
```

(Over,Down,Direction)
CRATER(2,6,NE)
ERUPT(12,2,S)
EXTINCT(8,7,NW)
MAGMA(7,2,E)
MANTLE(8,12,N)
OCCUR(4,1,SE)
VOLCANO(7,7,W)

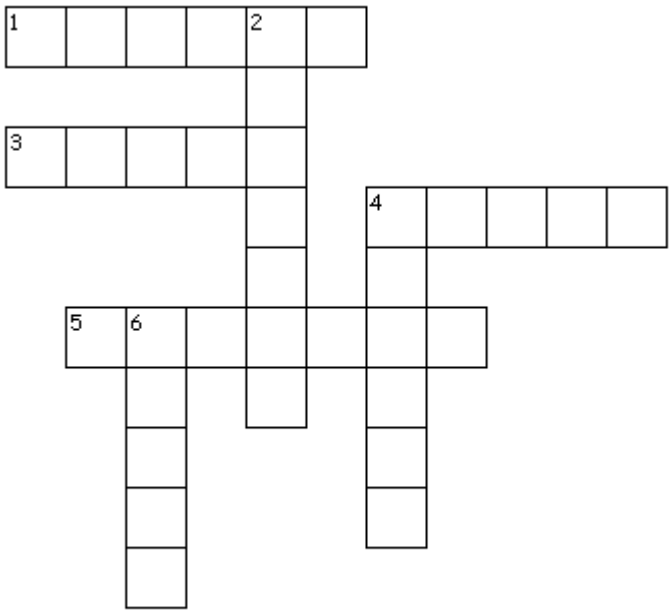
# Volcano Double Puzzle




Unscramble each of the clue words.
Copy the letters in the numbered cells to other cells with the same number.

# Volcano Crossword




Across
1. a hollow in the shape of a bowl around the opening of a volcano or geyser
3. to burst forth
4. molten rock within the earth
5. an opening in the earth's crust from which hot or melted rock and steam come from

Down
2. no longer active or existing
4. the part of the earth's interior beneath the crust and above the central core
6. to present itself, to be found or met with

# Wind Energy

**Objective**

We will learn more about the energy of the wind by making a wind machine – a kite, and see how the wind moves it through the air.

**Science Background**

Wind is **created** when air moves from an area of high **pressure** to an area of low pressure. When air is heated, its **density decreases**. The warm air rises and produces an area of low pressure. Cooler, denser air, which produces an area of high pressure, moves in underneath the rising warm air. Many things need the movement of the wind to help them **function**. For example, kites need wind to help them fly in the air and wind turbines need wind to help them generate electricity.

Wind is needed in order to fly a kite. A kite creates an **obstacle** to the normal air flow which will cause the air to change direction and speed. When the air flows across the object's surface it moves faster over the kite while the flow across the lower surface of the kite moves more slowly. Air pressure could be **altered** due to the changing air speed and **results** in the kite being pushed higher producing lift and flight.

You will be reading about the wind, then building and flying your own kite!

# READING

**Discussion:** There are many ways that we can sense the wind. We can hear it, feel it, see it blow branches, and even sometimes smell it. What do you know about the wind?

**Prediction:** The wind is invisible, yet it can be a powerful force, uprooting trees and moving houses. What do you think your book will be about?

**Book List:**

Taking Flight — ISBN: 0-689-81224-8
Stephen Krensky
Grade Level: 5.3
AR Points: 0.5

The Wind Blew — ISBN: 0027459101
Pat Hutchins
Grade Level: 2.9
AR Points: 0.5

Gilberto and the Wind — ISBN: 0140502769
Marie Hall Ets
Grade Level: 2.8
AR Points: 0.5

**Summary:** How would you summarize your book for another student? Would you recommend it? Why or why not?

# Reading Comprehension Questions

Book Title: _____

Was your book fiction or non-fiction?_____

**Fiction Comprehension Questions**

1. Who is the main character of the story? _____
_____
_____

2. Can you describe the setting? _____
_____
_____

3. What is the main idea of the story? _____
_____
_____

**Non-fiction Comprehension Questions**

1. What is the main idea of the book? _____
_____
_____

2. What is the author's purpose for writing the book? _____
_____
_____

3. List three pieces of information that you have learned from your reading.
_____
_____

# Vocabulary

Created - _____

_____

_____

Pressure - _____

_____

_____

Density - _____

_____

_____

Decreases - _____

_____

_____

Function - _____

_____

_____

Obstacle - _____

_____

_____

Altered - _____

_____

_____

Results: _____

_____

_____

# Kites

**Hypothesis:** How high will your kite fly?

**Materials:** Kite Kit

**Procedure:**

1. Follow the instructions in the kite kit.

**Data:**

| | |
|---|---|
| Length of string | |

**Conclusions:**

1. What provided the energy to make the kite fly?
2. Was there enough wind to make the kite fly? How can you can you help your kite to fly if there isn't enough wind?
3. How would you describe your kite as it was up in the air?
4. How high will your kite fly?
5. Was your hypothesis correct?

# Teacher Resources

**On-line:**
Wikipedia: http://en.wikipedia.org/wiki/Kite
The Drachen Foundation: http://www.drachen.org/classroom_lessons.html
Energy Information Administration:
http://www.eia.doe.gov/kids/energyfacts/sources/renewable/wind.html

**Materials:**

The end of the string may not be connected to the spool of string, therefore if all of the string is let out while your student is flying his/her kite it will fly away. When your student gets close to the end of the string have them firmly hold the end of the string. Do not have them wind the end of the string around their hands, since the kite could pull the string tightly around their hand and cut off the circulation.

To launch the kite, stand with the wind at your back. Hold the line in one hand and the top of the kite in the other so that, the kite is right side up and the picture faces you. Toss the kite up into the wind. As the wind takes the kite up, let out more line. If the kite begins to drop, give a full, hard tug on the line to make the kite climb. As long as there is tension on the flying line, the kite will stay up.

The kite must be built properly in order to fly. If your kite seems to circle or dive to one side only, check to see if the bridle loop is tied at the exact center of the bridle. If it is not, detach your flying line and reposition the loop.

Kites should only be flown on a dry day when the wind is blowing. They should be flown in a wide-open space, free of trees, buildings and other large obstructions. If you have to walk or run with the kite, be sure to look in the direction you are going. Watch out for people, streets, or anything hazardous in your path. **Do not fly near electric power lines.**

**Suggestions:**

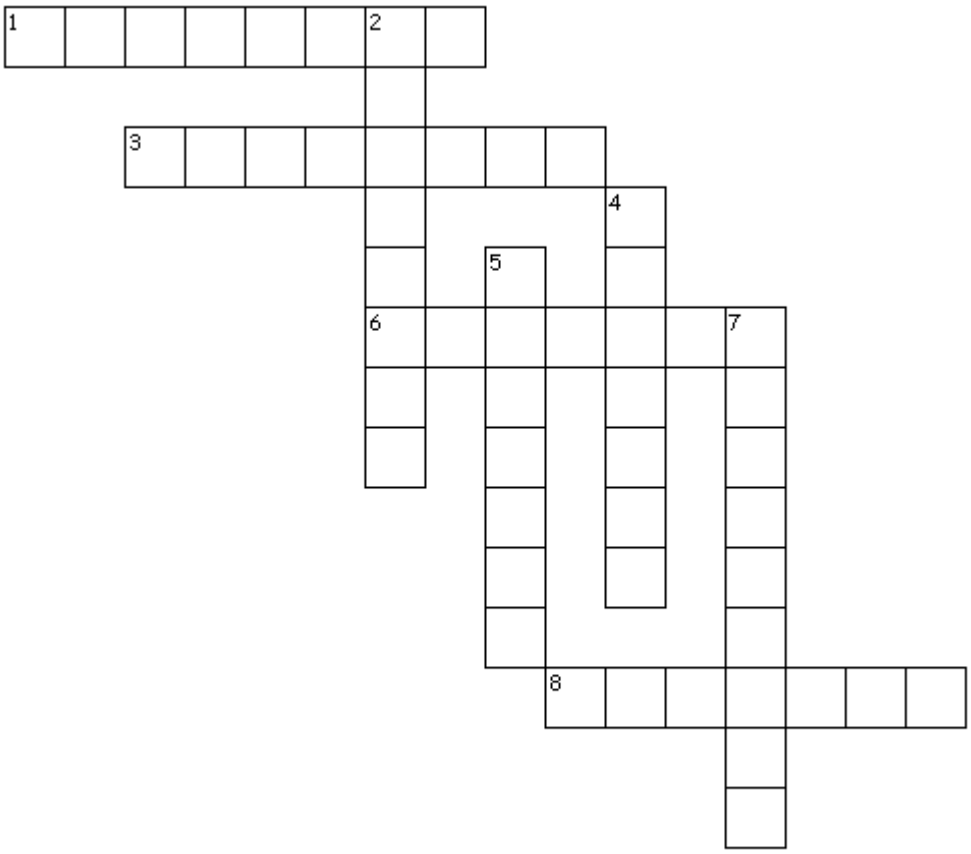
1. Try different kite designs. There are many variations that can be made to the basic design and students can experiment with different types and see how they compare.
2. Use the kite as a way of introducing the Chinese culture, which first experimented with kites almost three thousand years ago. These kites were not just recreational, but had military and communicational purposes.
3. Study how different animals are able to fly, and have students design their kite to be a flying animal or insect.

**Standards (see appendix A for detailed overview):**

**Physical Science 2 a)** - The position of an object can be described by locating it relative to another object or the background.



# Kite Crossword




Across
1. the action for which a person or thing is specially fitted or used
3. the force with which one thing pushes against another
6. to bring into existence
8. the amount of something crowded into a specific volume or area

Down
2. something that stands in the way
4. changed partly but not completely
5. to end as an effect
7. to reduce or lower

# Kite Word Search

A V O S Y R W K Y K T W F P T
D A B C T T B E W V O U N H P
R E S M I C J T X U N S A U M
D X T W S C I H B C X E G U U
F E A A N Z H D T P F A J D T
K L C J E V E I Y T Y T Q V R
B M L R D R O E R U S S E R P
C M E A E N C Q X P D J V U X
W W S T G A C X J H U U W L G
R L L C O F S X Y T A S V C Z
Y A C V K G V E U K R L Q Z Z
T C R Y Z O D G S E X M E W R
A F X G L Z T L X N Q N R Q L
R E S U L T S A U R J G E M H
V W O Y L L O S B A Y N C Z A

ALTERED
CREATED
DECREASES
DENSITY
FUNCTION
OBSTACLES
PRESSURE
RESULTS

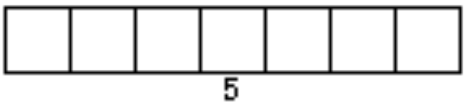
## Solution

```
+ + O + Y + + + + + + + F + +
D + B + T + + + + + + U + + +
+ E S + I + + + + + N + + + +
D + T + S + + + + C + + + + +
+ E A A N + + D T + + + + + +
+ + C + E + E I + + + + + + +
+ + L R D R O E R U S S E R P
+ + E + E N C + + + + + + + +
+ + S T + A + + + + + + + + +
+ + L + + + S + + + + + + + +
+ A + + + + + E + + + + + + +
+ + + + + + + + S + + + + + +
+ + + + + + + + + + + + + + +
R E S U L T S + + + + + + + +
+ + + + + + + + + + + + + + +
```

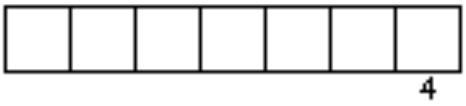
(Over,Down,Direction)
ALTERED(2,11,NE)
CREATED(7,8,NW)
DECREASES(1,4,SE)
DENSITY(5,7,N)
FUNCTION(13,1,SW)
OBSTACLES(3,1,S)
PRESSURE(15,7,W)
RESULTS(1,14,E)

# Kite Double Puzzle

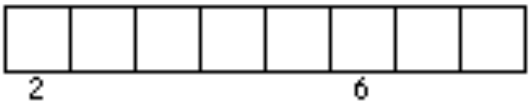
CETDEAR



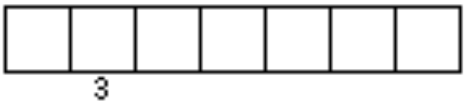

SIDTEYN



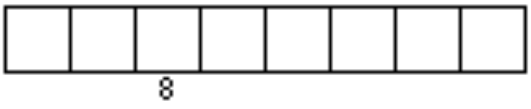

NTOUNICF



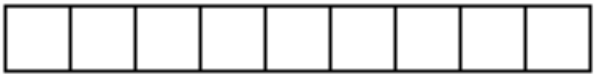

LEATEDR



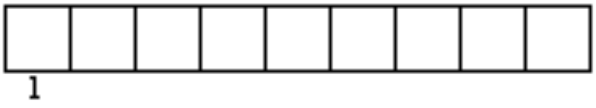

PERUSRES



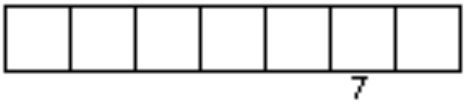

SERCESAED

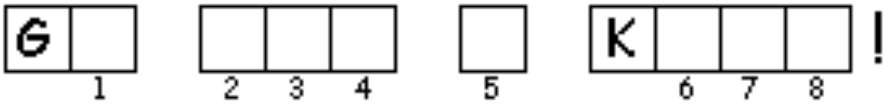


LOBTEACSS




STLUSRE




Unscramble each of the clue words.
Copy the letters in the numbered cells to other cells with the same number.

# Wind Power

**Objective**

We will read about the wind and learn how the winds energy can be used as a power source to create electricity by building a model wind turbine.

**Science Background**

Wind is a "renewable" resource, which means that it will never run out and can be used over and over. Wind **turbines** capture the wind's energy with two or three **propeller**-like blades, which are mounted on a **rotor**, to generate electricity. The turbines sit high atop towers, taking **advantage** of the stronger and less turbulent wind at 100 feet (30 meters) or more aboveground.

Wind is a clean, **inexhaustible**, **indigenous** energy resource that can generate enough electricity to power millions of homes and businesses. Wind energy is one of the fastest-growing forms of electricity generation in the world. The United States can currently generate more than 10,000 megawatts of electricity from the wind, which is enough to power 2.5 million average American homes. **Industry** experts **predict** that, with proper development, wind energy could provide 20% of this nation's energy needs.

You will be reading a book about wind power, and then building your own wind powered electricity generator.

# READING

**Discussion:** The sun is the primary source of wind on Earth. As it heats the planet, it gives the air the energy to move from one place to another. What do you know about wind?

**Prediction:** Wind is free and will always be available. We have been using the energy from the wind to grind grain, pump water and saw wood for thousands of years. What do you think your book will be about?

**Book List:**

Wind Power ISBN: 0-516-21943-X
Christine Petersen
Grade Level: 6.3
AR Points: 0.5

Generating Wind Power (Energy Revolution) ISBN: 0778729273
Niki Walker
ISBN: 0778729273
Grade Level: 7.2
AR Points: 1

Wind Power (Energy at Work) by Joseph Sherman
ISBN: 073685195X
Grade Level: 5
AR Points: 0.5

**Summary:** How would you summarize your book for another student? Would you recommend it? Why or why not?

# Reading Comprehension Questions

Book Title: _____

Was your book fiction or non-fiction?_____

**Fiction Comprehension Questions**

1. Who is the main character of the story? _____

_____

_____

2. Can you describe the setting? _____

_____

_____

3. What is the main idea of the story? _____

_____

_____

**Non-fiction Comprehension Questions**

1. What is the main idea of the book? _____

_____

_____

2. What is the author's purpose for writing the book? _____

_____

_____

3. List three pieces of information that you have learned from your reading.

_____

_____

# VOCABULARY

Turbines - _____

_____

_____

Rotor - _____

_____

_____

Inexhaustible - _____

_____

_____

Industry - _____

_____

_____

Propeller - _____

_____

_____

Advantage - _____

_____

_____

Indigenous - _____

_____

_____

Predict - _____

_____

_____



# Wind Turbine

**Hypothesis:** As wind speed increases what will happen to power output?

**Materials:** A small wind turbine kit, Electric fan (Box fan works best)

**Procedures:**

1. Construct your wind turbine according to the instruction in the wind kit.
2. Allow the glued tower to dry before use.
3. Set up a box fan on the floor. Place the wind turbine about 12 inches from the fan.
4. Turn on the fan at the lowest setting and record the brightness of the bulb in the table below. Repeat for the next highest settings.

**Data:**

| Fan Speed | LED brightness |
|---|---|
| | |
| | |
| | |

**Conclusion:**

1. What kind of energy does the wind turbine turn the wind energy into?
2. How does the wind speed affect the bulb brightness?
3. What kinds of places should wind turbines be placed?
4. As wind speed increases what will happen to power output?
5. Was your hypothesis correct?



# Teacher Resources

**On-line:**
Wikipedia: http://en.wikipedia.org/wiki/Wind_power
Department of Energy:
http://www.eia.doe.gov/kids/energyfacts/sources/renewable/wind.html
NREL: http://www.nrel.gov/learning/re_wind.html

**Materials:**

Wind turbine kits can be ordered from education supply stores. They can also built from basic materials, balsa wood dowels, an electric motor, and a light bulb. The amount of electricity will be small, and somewhat dependent on the quality of the electric motor.

The electric motor uses electricity and magnetism to change one form of energy into another. This is a reversible process, so that putting in electricity will cause the arm to rotate, while rotating the arm will cause electricity to flow. For the wind turbine, we use the wind to rotate the arm, and take the electricity that is produced. This is similar to a coal power plant which burns coal to create steam that turns a turbine as it travels upward.

**Suggestions:**

1. Use a multi-meter to record readings for the voltage and current produced by the wind turbine.



2. Compare the measured values to the wind power formula, below. Measurements will likely be 10-20% of the maximum theoretical value.

$$P = \frac{1}{2} p \pi r^2 v^3$$

p = Density of Air
r= Radius of your swept area (radius of your blades)
v= velocity of wind

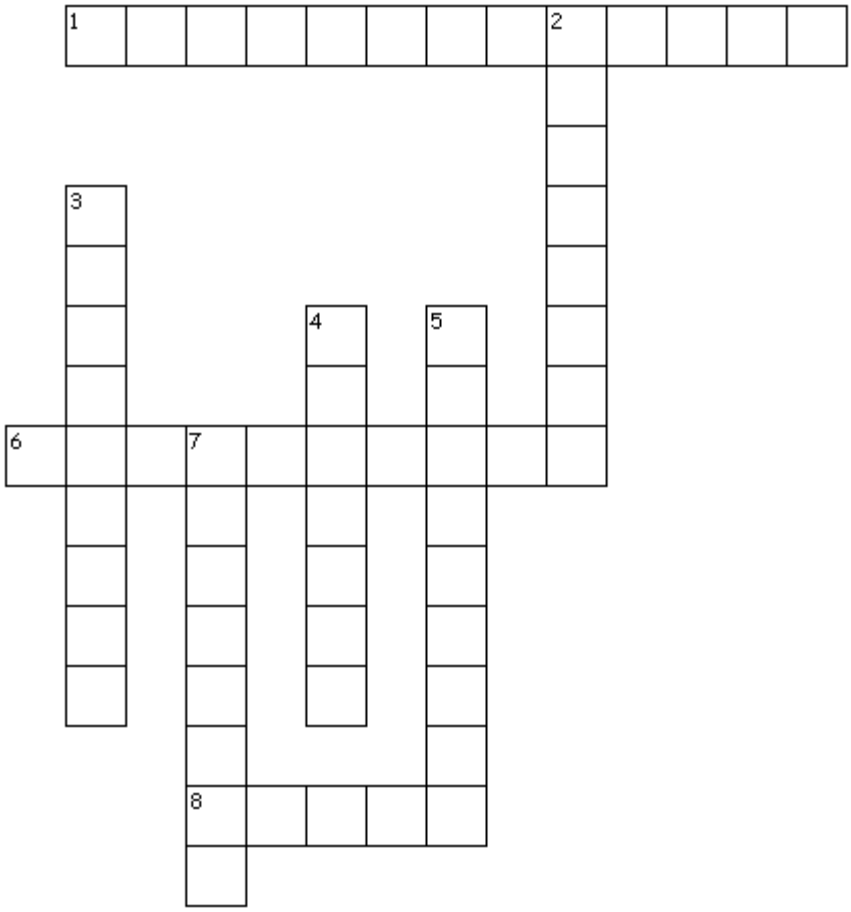
3. Wind can be a very powerful force (hurricanes, tornados). What if we could harness that power to power our homes? Wind turbines transfer wind energy (mechanical) into electrical energy. You can have your students discuss different weather phenomenon that are wind related: tornados, hurricanes, blizzards. You can then discuss what could happen if you could harness the power of the wind. You to talk about wind farms, costal wind farms, the best places for wind farms, what happens if the wind doesn't blow for a couple of days, etc.

**Standards (see appendix A for detailed overview):**

**Physical Science 2 c)** - The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.



# Wind Power Crossword




Across

1. plentiful enough not to be used up
6. coming from a particular region or country
8. the part of an electrical machine that turns

Down

2. engines whose central driving shafts are fitted with a series of wing like parts that are whirled around by the pressure of water, steam, or gas
3. the fact of being in a better position or condition
4. to figure out or tell beforehand
5. a device with a hub and blades that is made to turn that moves a ship, power boat, or airplane.
7. businesses that provide a certain product or service

# Wind Power Word Search

E P X G U Z O K C E S R M P Z
A D B Q A F P V G M I H Z R S
E L B I T S U A H X E N I E W
F I X B M R T S R F N Z Q D E
S U N E O N B O H G O N U I O
S U E D A W T K C K R Y Y C J
L C O V U O J Y K E E G F T E
L E D N R S L T E S L A Q O K
H A X C E K T B R T L U Y Z Y
T O W J O G D R K F E A I L N
B I F D S E I M Y J P F H R L
I J N T A M T D S M O H C R B
T U R B I N E S N S R P Z T T
D R Y N C B B Q O I P P Y S J
G C I U U J W E R X E B V C V

ADVANTAGE
INDIGENOUS
INDUSTRY
INEXHAUSTIBLE
PREDICT
PROPELLER
ROTOR
TURBINES

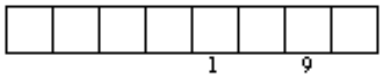
# Solution

```
+ + + + + + + + + E + + + P +
+ + + + + + + + + G + + + + R +
E L B I T S U A H X E N I E +
+ I + + + + T + R + + + + D +
S + N + + N + O + + + + + I +
+ U + D A + T + + + R + + C +
+ + O V U O + + + + E + + T +
+ + D N R S + + + + L + + + +
+ A + + E + T + + + L + + + +
+ + + + + G + R + + E + + + +
+ + + + + + I + Y + P + + + +
+ + + + + + + + D + + O + + + +
T U R B I N E S N + R + + + +
+ + + + + + + + + + I P + + + +
+ + + + + + + + + + + + + + +
```

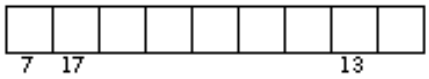
```
(Over,Down,Direction)
ADVANTAGE(2,9,NE)
INDIGENOUS(10,14,NW)
INDUSTRY(2,4,SE)
INEXHAUSTIBLE(13,3,W)
PREDICT(14,1,S)
PROPELLER(11,14,N)
ROTOR(9,4,SW)
TURBINES(1,13,E
```

# Wind Power Double Puzzle

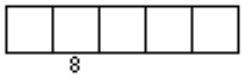
TERSUBIN



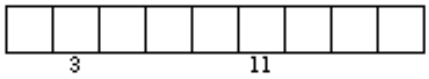

PELROPREL



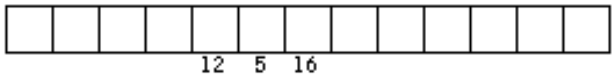

ROTRO



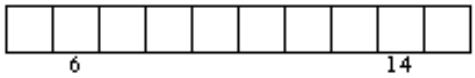

TADNEVGAA



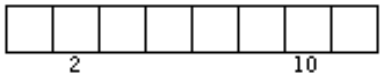

BAESIXLEUTIHN



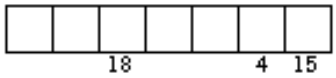

NONGESDIIU

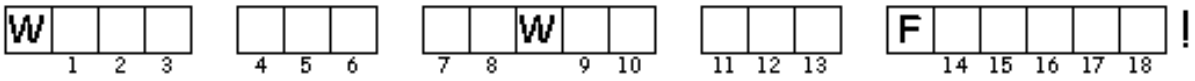



RYNSIDTU

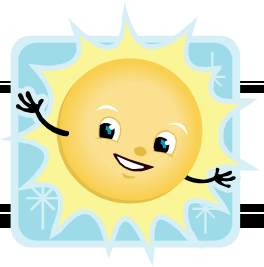



TIDPERC




Unscramble each of the clue words.
Copy the letters in the numbered cells to other cells with the same number.



# Solar Power

**Objective**

We will build a solar powered car to see how the sun's energy can be made directly into electricity using solar cells.

**Science Background**

**Solar** power is a "renewable" resource, which means that it will never run out and can be used over and over. The sun's energy can be used to **provide** heat, light, electricity and hot water, for homes, businesses, and industry.

Solar cells **convert** sunlight directly into electricity. Solar cells are often used to power calculators and watches. They are made of semi-conducting materials **similar** to those used in computer chips. When sunlight is **absorbed** by these materials, the solar energy knocks **electrons** loose from their atoms, allowing the electrons to flow through wires to **produce** electricity. This process of converting light (photons) to electricity (**voltage**) is called the photovoltaic (PV) effect.

You will be reading about solar power, and then build your own solar powered car!

# READING

**Discussion:** Life on Earth could not exist without the sun. Sunlight provides enough energy to warm our planet and support a wonderful variety of living things. What do you know about energy from the sun?

**Prediction:** Energy from the sun can be collected and used in our homes. Photovoltaic cells convert the sun's energy to electricity. What do you think your book will be about?

**Book List:**

Solar Power — ISBN: 0-516-21941-3
Christine Petersen
Grade Level: 6.5
AR Points: 0.5

Solar Power (Energy at Work) — ISBN: 0736851941
Joseph Sherman
Grade Level: 4.8
AR Points: 0.5

Solar Power (Energy Forever Series) — ISBN: 0817253629
Ian Graham
Grade Level: 7.4
AR Points: 1.0

**Summary:** How would you summarize your book for another student? Would you recommend it? Why or why not?

# Reading Comprehension Questions

Book Title: _____

Was your book fiction or non-fiction?_____

**Fiction Comprehension Questions**

1. Who is the main character of the story? _____
_____
_____

2. Can you describe the setting? _____
_____
_____

3. What is the main idea of the story? _____
_____
_____

**Non-fiction Comprehension Questions**

1. What is the main idea of the book? _____
_____
_____

2. What is the author's purpose for writing the book? _____
_____
_____

3. List three pieces of information that you have learned from your reading.
_____
_____



# VOCABULARY

Solar - _____

_____

_____

Provide - _____

_____

_____

Convert - _____

_____

_____

Similar - _____

_____

_____

Absorbed - _____

_____

_____

Electrons - _____

_____

_____

Produce - _____

_____

_____

Voltage - _____

_____

_____



# Solar Sprint

**Hypothesis**: How long will it take your solar racer to go five meters?

**Materials**: Solar car, meter stick, stop watch

**Procedure**:

1. Measure out a distance of five meters. Record this distance in the data table below.
2. Have a partner time your solar car from start to finish. Record this time in the data table below. Race your car three times.
3. Switch with your partner and use the stopwatch to measure the time it takes the solar car to go five meters.

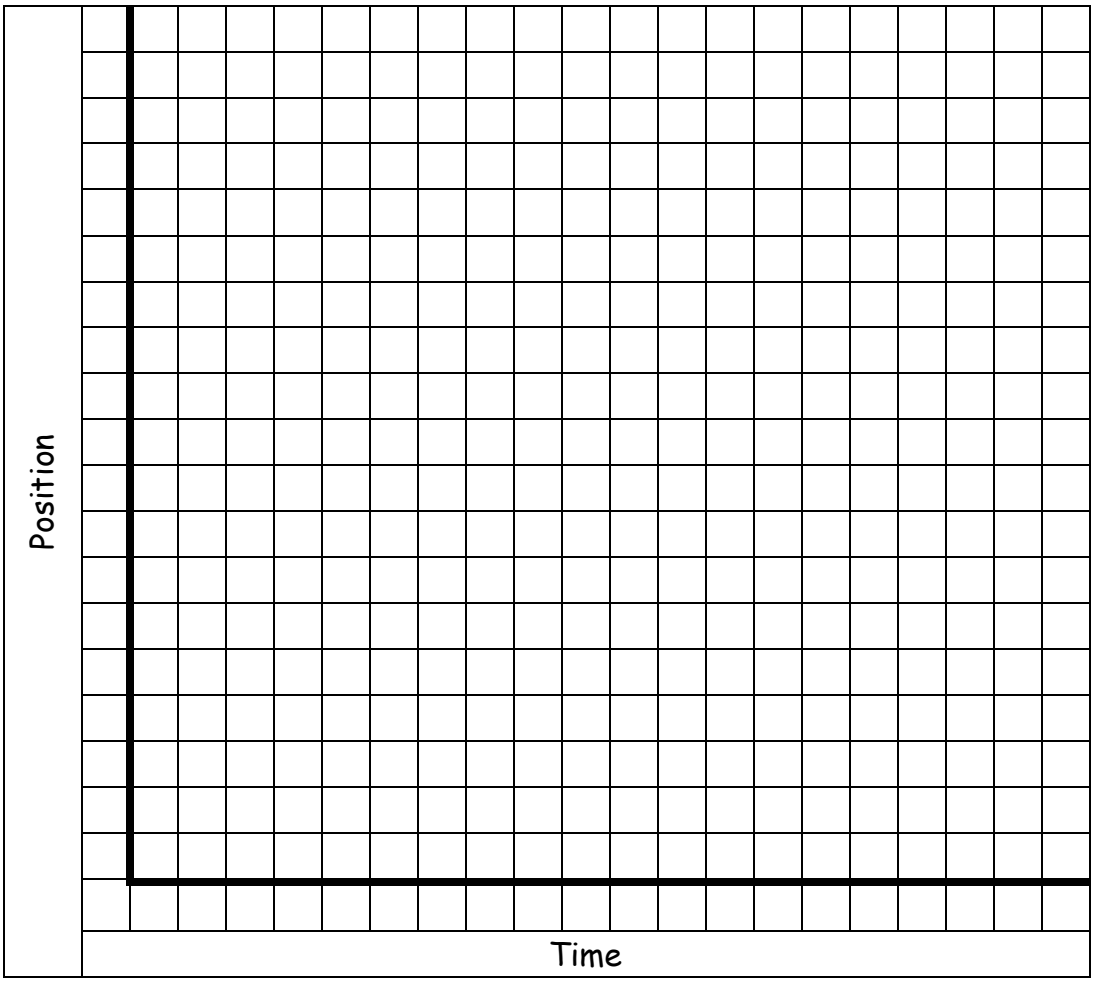
**Data**:

| Trial | Distance | Time |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

**Conclusions**:

1. Draw a graph of the position vs time for each trial.
2. Which trial did the car go the fastest? Which line is the steepest?
3. In order to win the race, would you want the solar racer with the highest time or the lowest time?
4. How long did it take your solar racer to go five meters?
5. Was your hypothesis correct?

# Position vs Time Graph




**Remember to:**

1. Label axis
2. Plot final position and time for each trial
3. Draw a straight line from start to finish for each point

# Teacher Resources

**On-line:**
Wikipedia: http://en.wikipedia.org/wiki/Solar_power
Powerhouse Kids:
http://www.powerhousekids.com/stellent2/groups/public/documents/pub/phk_ee_re_001505.hcsp
NREL: http://www.nrel.gov/learning/re_solar.html

**Materials:**

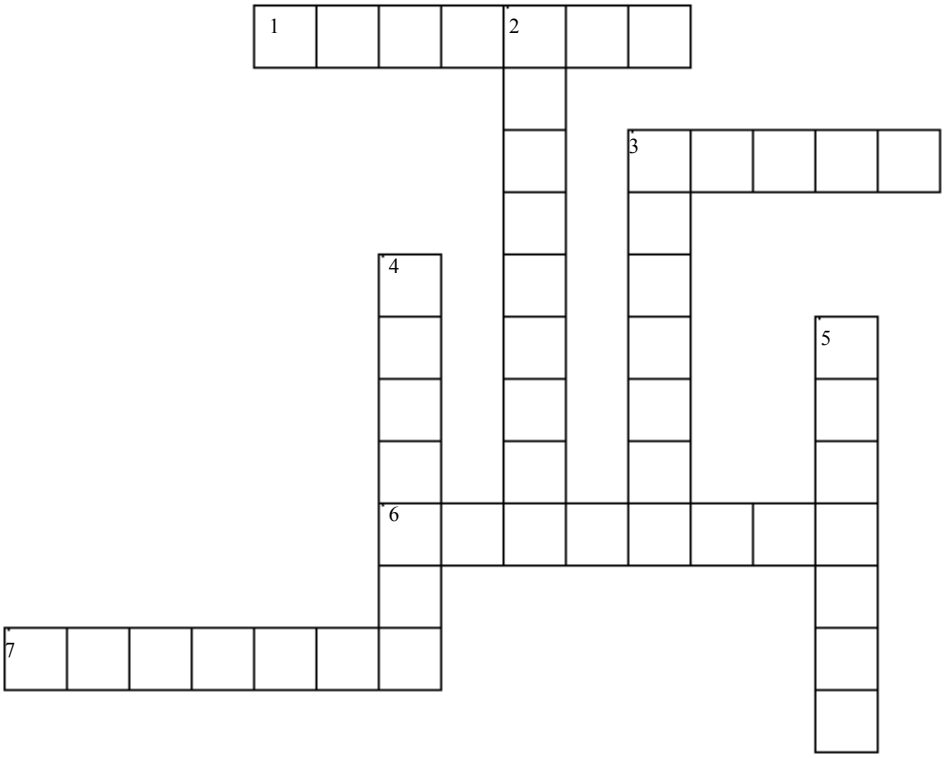
The solar car kit makes building the solar car a snap. The pieces should easily click together to be built in a 20-30 minute period. There is also some flexibility in the design since different gears are provided.

**Suggestions:**

1. Students can be given more time to decorate their solar racers, and awards can be given out for fastest car and best design.
2. Discuss with students the different design choices and how they affect the car speed. Ideas such as aerodynamics, gears, and weight should be mentioned.
3. Have students interpret other distance time graphs to see which car won the race, which was going the fastest, or the slowest, or which car stopped during the race.

**Standards (see appendix A for detailed overview):**
**Physical Science 2 b)** - An object's motion can be described by tracing and measuring its position over time.

# Solar Power Crossword




Across
1. to change from one form to another
3. of or relating to the sun
6. to take in or swallow up
7. to give something that is needed

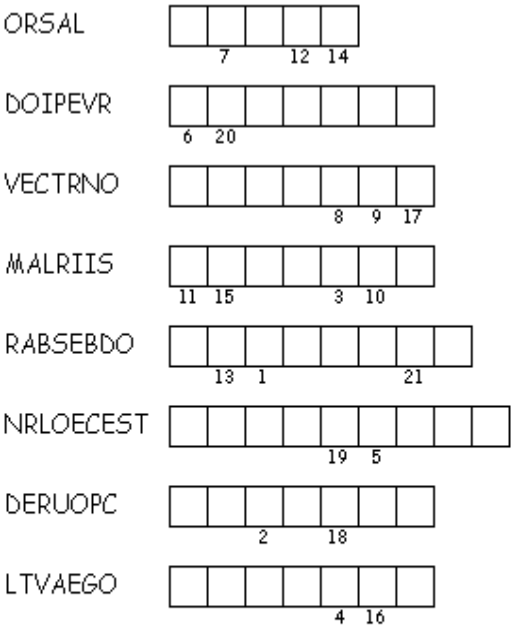
Down
2. very small particles that have a negative charge of electricity
3. having qualities in common
4. electrical force measured in volts
5. to bring forth

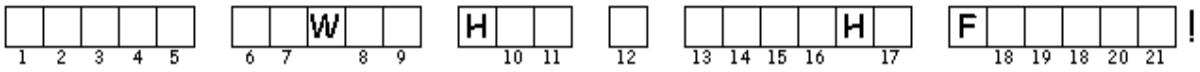
# Solar Power Word Search

S J H L E U A T E G I W S X R
C N L Y H I U Z T D E H P G D
U F O F Z F D R Y S O L W S Q
K D T R J F E K V I R W Y Y J
C E R N T V L O V M R A L O S
T B R F N C L B V I N K I Q J
G R T O N T E N X L X I N U A
W O C K A S Q L D A O T H B K
R S O G P N P L E R G O N D B
Q B E U Y R G R E M Q S V M W
G A O O P R O D U C E C Q O F
L X F H H M J V L K R N B M W
S H Y M D H X R I P B L S Q Y
F I F Z B O U Z C D L F J A P
I V O H K L I J G A E T E D Q

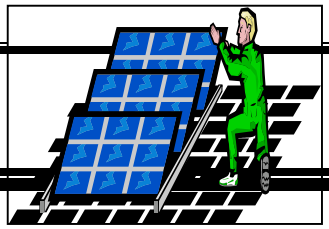
ABSORBED
CONVERT
ELECTRONS
PRODUCE
PROVIDE
SIMILAR
SOLAR
VOLTAGE

# Solar Power Double Puzzle




Unscramble each of the clue words.
Copy the letters in the numbered cells to other cells with the same number.



# Solar Energy

**Objective**

We will learn about the characteristics of the sun, and build a small oven to learn how the energy from the sun can be used as heat.

**Science Background**

The sun is very important to the Earth. Without it, there would be no life on our **planet**. We can use the energy of the sun to warm and light our homes, heat our water, and provide electricity to power our lights, stoves, refrigerators and other **appliances**. Almost all of the energy on Earth **originated** with the sun. It is the source of our weather, such as wind and rain, which we can use to make electricity with windmills and dams. Most of our electricity comes from coal, which is energy stored from the sun in plants millions of years ago.

The sun is an **abundant** energy resource. The simplest use of the sun is to use its warmth to heat up an object. The **passive** heating effect of the sun can be used **successfully** and **economically** as an energy source to heat houses and buildings, to heat water and to even cook food. Even today, many people around the world **depend** on the energy from the sun to cook food.

You will be reading a book about the sun, and then using its energy to cook a tasty snack!



# READING

**Discussion:** The sun is the center of our solar system. All the planets orbit around the sun. What do you know about the sun?

**Prediction:** The sun is made up of hot gasses. Not only does the sun give us heat and light, but also it's responsible for our weather patterns. What do you think your book will be about?

**Book List:**

Solar Power of the Future: New Ways of Turning Sunlight into Energy
ISBN: 823936635
Susan Jones
Reading Level: 8.3
AR Points: 1.0

Lizard and the Sun ISBN: 0440415314
Alma Flor Ada
Reading Level: 4.4
AR Points: 0.5

The Sun is My Favorite Star ISBN: 152021272
Frank Asch
Reading Level: 1.9
AR Points: 0.5

**Summary:** How would you summarize your book for another student? Would you recommend it? Why or why not?



# VOCABULARY

Planet - _____

_____

_____

Appliances - _____

_____

_____

Originated - _____

_____

_____

Abundant - _____

_____

_____

Passive - _____

_____

_____

Successfully - _____

_____

_____

Economically - _____

_____

_____

Depend - _____

_____

_____



# Solar Ovens

**Hypothesis:** How long does it take the sun to cook S'mores?

**Materials:** 1 box with a pre-cut rectangle on the top of the lid, masking tape, scissors, clear plastic wrap or transparency paper, aluminum foil, black paper plate, stopwatch

**Procedure:**

1. Fold the cardboard box into its boxed shape by starting with the bottom corners.
2. Gently fold the "pre-cut" flap on the top of the box, back along the uncut edge to form a crease.
3. Wrap the underside (inside) face of this flap with aluminum foil and fold it over the outside face of the flap.
4. Smooth it out so the aluminum foil is tight and tape the aluminum so that the foil is held firmly.
5. Stretch the plastic wrap across the opening on the outside portion of the box and make sure it is tight.
6. Completely tape the edges of the plastic wrap keeping it tight. The plastic wrap should almost be to the edge of the opening.
7. Place the oven on a sunny flat surface facing the sun and use masking tape to prop the aluminum flap open. Sunlight should reflect off the flap and into the solar oven window.
8. Finally, prepare your S'more with graham crackers, chocolate, and marshmallows and place them on the black plate.
9. Slide the S'more into the center of your solar box oven, close the lid tightly and adjust the aluminum flap as needed.
10. Use the stopwatch to time how long it takes to cook the S'mores the way you want it. Depending on the day, your S'mores should be ready to eat in no time. Enjoy!
11. As the S'more is cooking skip to the next section and read about sunlight and make your solar bracelet.

**Data:**

| | |
|---|---|
| Cooking time | |

**Conclusions:**

1. Where does most of the energy on our planet come from?
2. What are three things the sun can do?
3. What other food could you cook with the sun?
4. How long does it take the sun to cook S'mores?
5. Was your hypothesis correct?



# Teacher Resources

**On-line:**
Wikipedia: http://en.wikipedia.org/wiki/Solar_cooker
The Energy Story: http://www.energyquest.ca.gov/story/chapter15.html
Department of Energy:
http://www.eia.doe.gov/kids/energyfacts/sources/renewable/solar.html

**Materials:**

Remember, black absorbs heat, so the construction paper will help draw heat into the box. This aluminum flap will help reflect the sunlight into the box to increase the temperature. The plastic wrap works as an insulator to keep the heat inside of the box. **Note:** You do not have to do this if you are using a transparency sheet.

One of the easiest and most enjoyable solar oven snacks is S'mores. This way, if it's cloudy and the food doesn't really cook, the students can still eat cold S'mores. The recipe calls for graham crackers, marshmallows, and chocolate bars.

**Suggestions:**

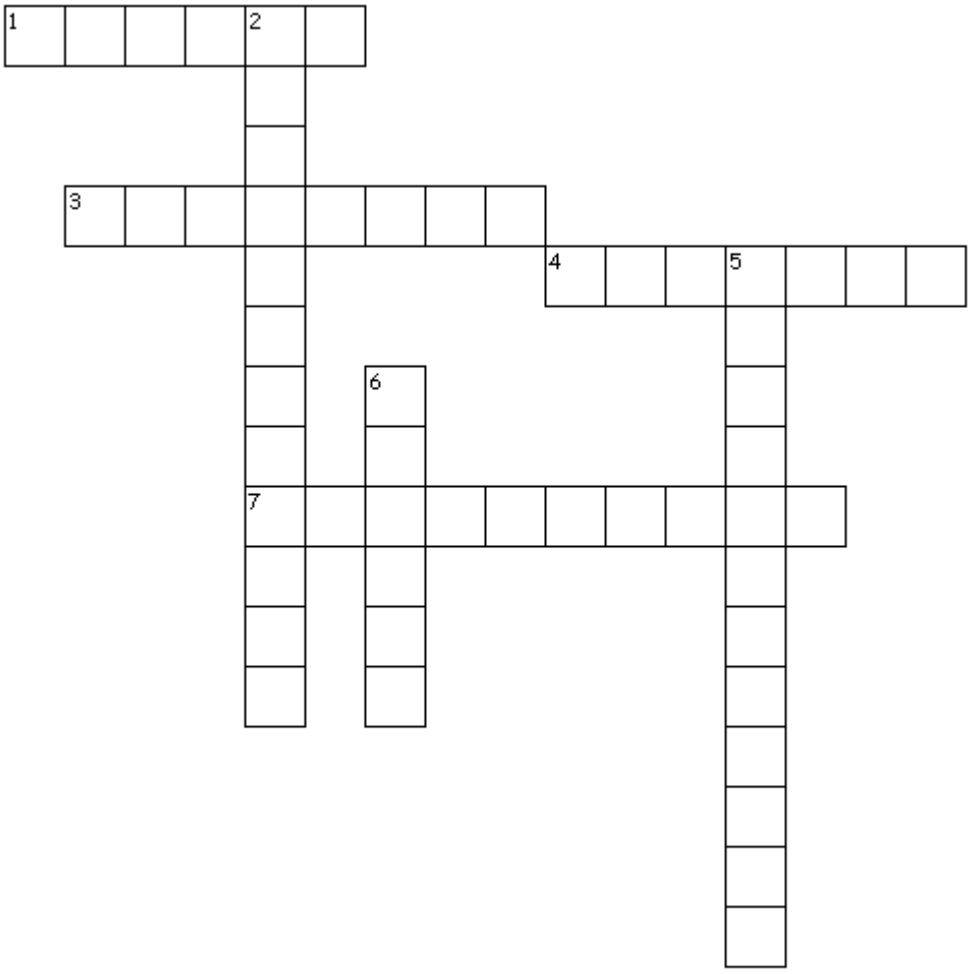
1. Consider other recipe possibilities with the solar oven. Almost any food can be cooked in a solar oven. The efficiency of the oven will limit what can be cooked.
2. Discuss the use of solar energy for cooking in third world countries. One third of the world still depends on collecting wood for burning to cook their food. There are programs aimed at bringing affordable and efficient solar cooking to these people, saving them time out of their day and limited local resources. Solarcooking.org is one such organization.
3. Current coal power plants burn coal to heat water into steam that can turn a generator. Consider the current research into solar thermal electricity generation, which replaces the limited fossil fuel with the energy of the sun to boil water to steam. NREL is researching this field and discusses the applications at http://www.nrel.gov/learning/re_csp.html.

**Standards (see appendix A for detailed overview):**

**Physical Science 3 b)** - Heat can be produced in many ways, such as burning, rubbing, or mixing one substance with another. Heat can move from one object to another by conduction.



# Solar Energy Crossword




Across
1. a celestial body other than a comet or meteor that travels in orbit about the sun
3. more than enough
4. acted upon, offering no resistance
7. devices designed for certain use

Down
2. using what one has carefully and without waste: frugal
5. having gained satisfactory completion of something
6. to be determined by or based on some action or condition; to rely on for support

# Solar Energy Word Search

B Y X P R C N E P D S D Y C H
A G L V A H S L Q E U E L K H
W J I L K S A C C P H T B C Q
A B T Y U N S N N E O A M F L
Q X E C E F A I N N F N W M C
I B U T Z I S N V D L I A G C
Q U C N L Y O S D E N G N Z M
V A Q P P S B S E T C I L K R
V B P B D G Q B G C W R F M S
I A B U N D A N T F C O K L X
P G G T J I D V E Y L U X K H
Y L L A C I M O N O C E S N R
H A M P J U L F F E Q Q J X D
K O B Q G E W N V X O F R S L
V L C K T N N L A T A R L K H

ABUNDANT
APPLIANCES
DEPEND
ECONOMICALLY
ORIGINATED
PASSIVE
PLANET
SUCCESSFULLY



## Solution

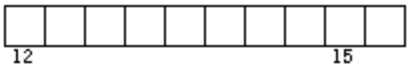
```
+ Y + P + + + + P D S D + + +
+ + L + A + + L + E + E + + +
+ + + L + S A + C P + T + + +
+ + + + U N S N + E + A + + +
+ + + + E F A I + N + N + + +
+ + + T + I S + V D + I + + +
+ + + + L + + S + E + G + + +
+ + + P + + + + E + + I + + +
+ + P + + + + + + C + R + + +
+ A B U N D A N T + C O + + +
+ + + + + + + + + + U + + +
Y L L A C I M O N O C E S + +
+ + + + + + + + + + + + + + +
+ + + + + + + + + + + + + + +
+ + + + + + + + + + + + + + +
```

(Over,Down,Direction)
ABUNDANT(2,10,E)
APPLIANCES(2,10,NE)
DEPEND(10,1,S)
ECONOMICALLY(12,12,W)
ORIGINATED(12,10,N)
PASSIVE(4,1,SE)
PLANET(9,1,SW)
SUCCESSFULLY(13,12,NW)

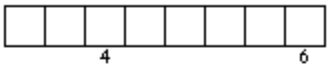


# Solar Energy Double Puzzle

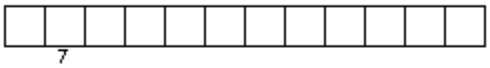
SALNIPCEAP



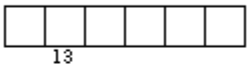

BADNUNTA



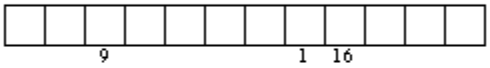

SEUCYCSULFLS




DEDENP

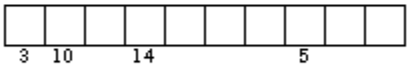



CAOLICNLOEMY

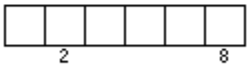


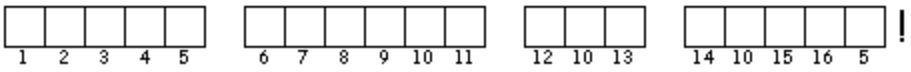

VPSASEI


GEDTINRIOA

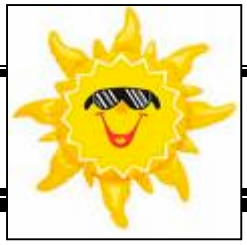



PELTAN




Unscramble each of the clue words.
Copy the letters in the numbered cells to other cells with the same number.



# Sunlight

**Objective**

We will investigate the many colors of sunlight, including the ones we can't see.

**Science Background**

Sunlight is comprised of light energy that occurs at many different levels. Each of these energy levels makes a different color. The color blue has more energy than the color red. Our eye detects these energy levels so that we can see color. We are most familiar with visible light that allows us to see all the colors of the rainbow, red, orange, yellow, green, blue, indigo, and violet (we use ROY G. BIV to remember these colors in order). There are even more colors of light, but our eyes can't see them. There are still ways to detect this light, even if we can't see it.

The primary colors of light are red, green and blue. You can mix these three colors together to get any other color in the rainbow. When all three colors are mixed together they create white light. When you see a color, your eye is mixing the red, green, and blue light to create the color you see. Even though you can't see some colors, you can still feel them. Infrared is a color you can't see, but is responsible for making you feel warm when you go in the sun. Ultraviolet is a color you can't see, but is responsible for giving you a sunburn.

We will be reading a book to find out more about the colors in sunlight, then we will make our own ultraviolet light detector!

# ACTIVITY LESSON

**Hypothesis:** How does sunscreen protect people from being burned?

**Materials:** 12 Ultraviolet Light Detecting Beads (variety), 13" Rawhide string (15" for adults), Sunscreen

**Procedure:**

1. Take the rawhide string and tie a knot about 5 inches from one end of the string.

4. Now slip the last bead through one end of the bracelet. Take the other end of the bracelet and slip it through this same bead.
5. Once each end of the string has been slipped through the bead, tie a knot at the end of each string.
6. Slip the bracelet over your wrist and ask your tutor to pull the end of each string to fit the bracelet to your wrist. Write your observations of the beads.
7. Dab a little sunscreen on half the beads.
8. Go outside to see what the ultraviolet rays from the sunlight will do to your beads. Record your observations of the solar beads with and without sunscreen.

**Data:**

| **Beads** | **Observations** |
|---|---|
| Before sun | |
| After sun<br>with sunscreen | |
| After sun<br>without sunscreen | |

**Conclusions:**

1. What happened to the beads that were taken into the sunlight without sunscreen?
2. What happened to the beads that were taken into the sunlight with sunscreen?
3. What causes the beads to change color?
4. How does sunscreen protect people from being burned?
5. Was your hypothesis correct?

# Teacher Resources

**On-line:**
Wikipedia: http://en.wikipedia.org/wiki/Color
Exploratorium: http://www.exploratorium.edu/exhibits/mix_n_match/
How Stuff Works: http://science.howstuffworks.com/light2.htm

**Materials:**

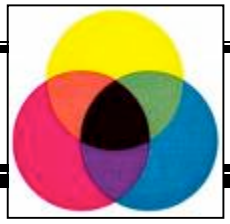
The UV sensitive beads contain a pigment that changes color when exposed to ultraviolet light. When you bring them out into sunlight and the ultraviolet rays of the sun hit the beads, they change color.

**Suggestions:**

1. Have students bring in sunglasses and see which ones are UV protected by placing the beads under the lens. Look at other materials that block UV light, and therefore keep us from being sunburned. For example, glass windows will not allow UV light through.
2. Take the solar beads out on a cloudy day, and students may be surprised to see the beads still change color. UV light is able to penetrate clouds, and it is still quite possible to get sunburned on a cloudy day. Have students use the beads to detect when and where they should where sunscreen.
3. Experiment with other sources of light besides the sun. Most incandescent light bulbs emit light in the visible to infrared spectrum, and won't affect the beads. Other lights, such as blacklights emit in the UV spectrum and may produce enough UV energy to change the colors of the beads. Discuss how black lights have their luminescent qualities, though the bulb looks dark, the UV energy can be absorbed and then reflected as colors we can see, usually a bright purple color, since that is the visible color UV light is closest to in the spectrum. White objects especially glow because white is best at reflecting the majority of the color spectrum back to us.

**Standards (see appendix A for detailed overview):**

**Physical Science 3 a)** - Light travels in a straight line until it strikes an object. Light can be reflected by a mirror, refracted by a lens or absorbed by the object.



# Colors

**Objective**

We will gain an understanding of how colors can be mixed to create new and different colors by making colorful filter paper discs using water to separate the colors.

**Science Background**

All paints, inks, and **dyes** are created by mixing any of the three **primary** colors together. The primary colors of paints, inks and dyes are blue, red and yellow. If you mix any of these colors together you will get a different color. However, if you mix all of these colors together, you will get the color black.

**Chromatography** is the process of **separating** and **analyzing** the **complex** mixtures of gases and chemicals by allowing the different parts of the mixture to move through an absorbent material at different **rates**. Some parts of a **mixture** move through the absorbent material more easily than others. This makes some of the parts move faster than others do. It is like a group of people running a race. At first they will be all together in the group. At the end of the run, they will be separated because some were able to run faster than others.

You will be reading about colors, then you will experimenting with mixing and separating your own color designs!



# READING

**Discussion:** Red, Blue and Yellow are the three primary colors of paints. If you mix all of the primary colors together you will get the color black. What do you know about mixing colors?

**Prediction:** New colors can be made when you mix any of the primary colors together. What do you think your book will be about?

**Book List:**

The Color Kittens ISBN: 0-307-10234-3
Margaret Wise Brown
Reading Level: 3.5
AR Points: 0.5

A Color of His Own ISBN: 0375836977
Leo Lionni
Reading Level: 2.3
AR Points: 0.5

All the Colors of the Rainbow (Rookie Read-About Science) ISBN: 051626415X
Allan Fowler
Reading Level: 3.6
AR Points: 0.5

**Summary:** How would you summarize your book for another student? Would you recommend it? Why or why not?



# Reading Comprehension Questions

Book Title: _____

Was your book fiction or non-fiction?_____

**Fiction Comprehension Questions**

1. Who is the main character of the story? _____
_____
_____

2. Can you describe the setting? _____
_____
_____

3. What is the main idea of the story? _____
_____
_____

**Non-fiction Comprehension Questions**

1. What is the main idea of the book? _____
_____
_____

2. What is the author's purpose for writing the book? _____
_____
_____

3. List three pieces of information that you have learned from your reading.

_____
_____

# VOCABULARY

Dyes - _____

_____

_____

Primary - _____

_____

_____

Chromatography - _____

_____

_____

Separating - _____

_____

_____

Analyzing - _____

_____

_____

Complex - _____

_____

_____

Mixture - _____

_____

_____

Rates - _____

_____

_____



# ACTIVITY LESSON

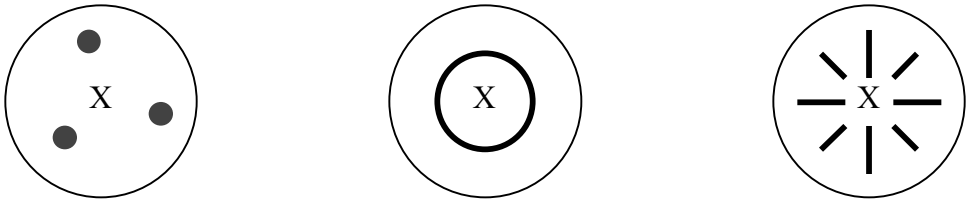
**Hypothesis:** Mixing colors can create new colors, but can colors be unmixed?

**Materials:** 3 coffee filter discs, 3 - 1½" pieces of pipe cleaner, 3 small medicine cups or 1 oz. plastic cups, Water, Brown Vis-à-vis marker, Small plastic dropper, rubbing alcohol, CLOUT T-shirt, Plastic Cups – 3 large, 3 medium, and 3 small, 6 Rubber bands, Sharpie markers – 4 assorted colors

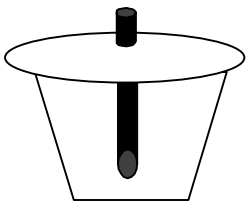
**Procedure:**

*Color Unmixing:*

1. Lay the three white filter discs flat on the desk and draw an "x" with your pencil in the middle of each disc.
2. Using the black Vis-à-vis marker, make 3 dots equally spaced about the "x" of one of the filter discs, a circle around the "x" of the second filter disc, and a series of lines around the "x" of the third filter disc. (See below)




3. Insert the pipe cleaners through the "x" of each filter disc so that a small part of it is poking through the top of the hole. Test the length of the pipe cleaner by putting the disc and pipe cleaner into the cup with the long end down. The pipe cleaner should not touch the bottom of the cup.

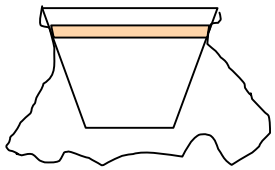


4. Fill the three little cups with water so that it is within ¼ inch of the top rim and place each filter disc onto the cups.

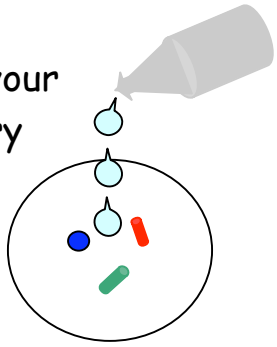
5. Carefully place the entire assembly out of your way and go on to Color Mixing.

*Color Mixing:*

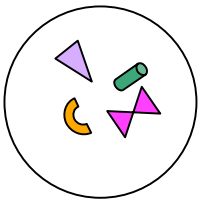
6. Write your name on the T-shirt label with one of the Sharpie markers.



7. Stretch a section of the T-shirt over the top of a large cup and secure the t-shirt to the cup using a rubber band (Side view).
8. Using one of the Sharpie markers, make 2 or 3 simple marks close to the center of the part of the T-shirt stretched over the cup. Try not to have any of your marks actually be directly in the center. Also, try not to have your marks too close to the edge of the circle.



9. Now take the dropper bottle and drip approximately **20 drops** of rubbing alcohol **directly on the CENTER of the circle**. If you want the ink to spread more, add additional drops of alcohol.
10. Leave the cup and rubber band where it is.



11. Take another cup and another rubber band and, on a different part of the T-shirt, do the same thing we did the first time – stretch the T-shirt over the cup and secure it with the rubber band.
12. Now use markers with some colors other than those you used the first time and make more marks within the circle.
13. Be creative with the marks you make. Here are a few to give you some ideas.

14. Continue this process and make a few more colorful circles on your T-shirt.

**Data**: (Completed Tie Dye T-Shirt)

**Conclusions**:

1. What happened to the color drops on the filter paper?
2. What colors were mixed to make the colors you used on the filter paper?
3. What happened to the colors on your T-shirt?
4. Mixing colors can create new colors, but can colors be unmixed?
5. Was your hypothesis correct?



# Teacher Resources

**On-line:**

Wikipedia: http://en.wikipedia.org/wiki/Tie-dye

Webopedia:
http://www.webopedia.com/DidYouKnow/Computer_Science/2002/Color.asp

Exploratorium:
http://www.exploratorium.edu/science_explorer/black_magic.html

**Materials:**

When marking the color filter paper, don't make too many marks – use less than 8 marks total. Keep your marks close to the middle of the circle. Water soluble markers or food dye should give good patterns. Pay attention to how the colors mix and which colors mix to create new colors or effects that you like so that you can repeat the ones you like best.

The colors from the markers are quickly absorbed into the T-shirt fabric. Normally, they would dry right there although they may "run" or "bleed" a little if you were to wash them. All of the T-shirts will need to be put in a clothes dryer so that the ink will not run when they get wet. Otherwise, when you put the T-shirt in the washer, all of your clothes will come out with multi-colors – which you or your parents may not like. Your teacher will take the T-shirts and put them all through the dryer so you will be able to take them home the following week. That is the purpose of putting your name on the t-shirt – so your program coordinator can return the t-shirts to the right person.

By using a solvent such as rubbing alcohol, the ink is "loosened" from the T-shirt fabric and it moves along with the rubbing alcohol as it spreads out and gets absorbed into the



cloth. The ink spreads out and becomes less concentrated as it spreads. As the ink from one color runs into the ink from another color, the colors mix in a manner similar to mixing paint.

**Suggestions:**

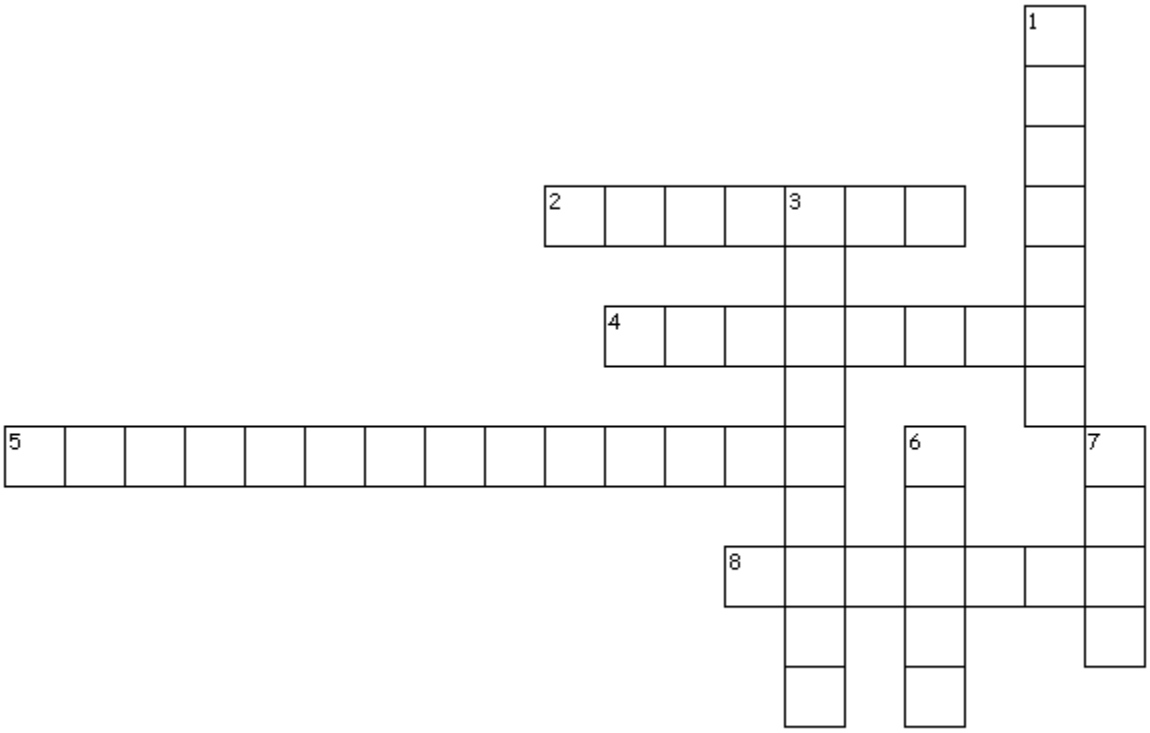
1. There are many different ways to tie dye the shirts. Another method you may want to try is to wrap the shirts up, then submerge them in the dye, as shown at http://www.kinderart.com/textiles/easytiedye.shtml. Many various patterns can be produced with marbles and rubber bands.
2. Experiment with the same color marker from different brands. You will find that different companies use different mixtures of color. A brown or black has a variety of color mixture options. Black is usually either red or blue based.
3. Have student time the color separation process, or run the experiment for a set amount of time between 10 and 15 minutes. Once they know how long the different inks traveled, they can measure the distance each traveled and calculate a diffusion speed for each color. Compare these speeds to other markers and other brands.

**Standards (see appendix A for detailed overview):**

**Physical Science 1 b)** - Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.



# Chromatography Crossword




Across
2. not made or coming from something else: basic
4. to set or keep apart
5. the separation of mixtures into their base parts
8. two or more substances mixed together

Down
1. not simple
3. to examine something to find out what it is or what makes it work
6. amount of something measured in units
7. a coloring substance used to add color to clothes, paper, etc

# Chromatography Word Search

L T C E G D X L W G V X S J G
F L H T R E Y L F C X E R O A
P O R E L U S E G T P P W X U
S C O P R D T F S A I L G M A
A Y M K K P C X R M B M Y N K
W O A O Y L B A I B G E R F F
C J T D L H T D G M E V A K B
Y D O G N I Z Y L A N A M T J
J F G X N D N N X S O L I D B
N U R G Y P J J F W I G R L X
O X A T L V S O P T T D P X Z
W P P G W V F J G X O L N S R
C A H A O K P E Q I I S G K T
U D Y O C O P H Y E N C X N B
R A T E S Z V U C P E P J B L

ANALYZING
CHROMATOGRAPHY
COMPLEX
DYES
MIXTURE
PRIMARY
RATES
SEPARATING

**Solution**

```
+ + C E + D X + + + + + S + +
+ + H + R E Y + + + + E + + +
+ + R + L U + E + + P + + + +
+ + O P + + T + S A + + + + +
+ + M + + + + X R + + + Y + +
+ O A + + + + A I + + + R + +
C + T + + + T + + M + + A + +
+ + O G N I Z Y L A N A M + +
+ + G + N + + + + + + + I + +
+ + R G + + + + + + + + R + +
+ + A + + + + + + + + + P + +
+ + P + + + + + + + + + + + +
+ + H + + + + + + + + + + + +
+ + Y + + + + + + + + + + + +
R A T E S + + + + + + + + + +
```

```
(Over,Down,Direction)
ANALYZING(12,8,W)
CHROMATOGRAPHY(3,1,S)
COMPLEX(1,7,NE)
DYES(6,1,SE)
MIXTURE(10,7,NW)
PRIMARY(13,11,N)
RATES(1,15,E)
SEPARATING(13,1,SW)
```

# Chromatography Double Puzzle

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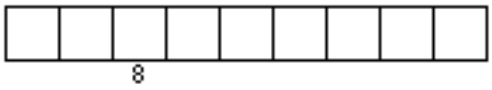
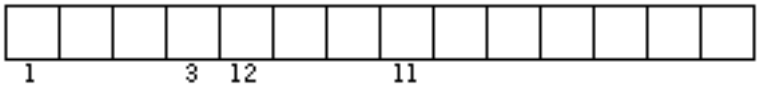
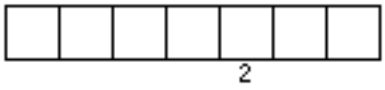


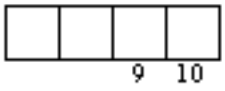

HRYPAAHOCROTMG



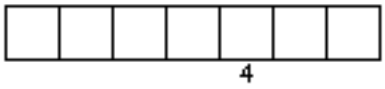

CEXMOPL



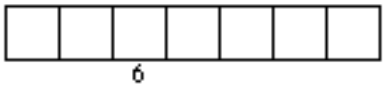

DEYS



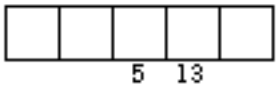

REMTIUX



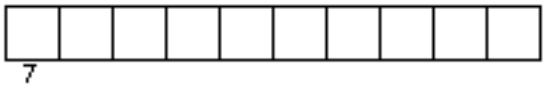

PIYMARR

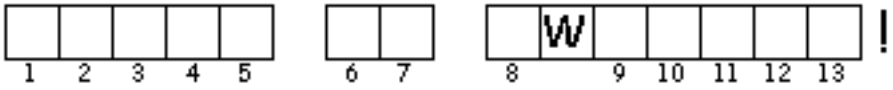



RATSE




NITARSEPGA




Unscramble each of the clue words.
Copy the letters in the numbered cells to other cells with the same number.

# Vanshing Resources

**Science Background**

The electricity we use to power our homes and the gasoline we use to drive our cars usually comes from one source: fossil fuels.

Fossil fuels are what is known as a nonrenewable **energy** source. Nonrenewable energy sources will not be around forever; once we have used them all up they are gone. These include **coal**, natural gas, and **oil**. Nonrenewable **resources** are quickly **vanishing** and we need to find another way to power our homes and cars.

Another type of energy is called renewable energy. Renewable energy sources are those which will be around forever, they include the sun, wind, plants and trees. We get **renewable** energy from many different places. **Biomass** comes from plants and trees, **solar** comes from the sun, **geothermal** comes from the heat inside the earth, and **hydropower** comes from the movement of water.

Today we will find out what will happen as our nonrenewable energy source get used up.

# Reading

**Discussion:** There are different types of fossil fuels, which ones do you know? What are some advantages and disadvantages to using fossil fuels?

**Prediction:** How long will it take before the fossil fuels run out?

**Book List:**

Fossil Fuels — ISBN: 978-0-8225-6736-3
Conrad J. Storad
Reading Level: 4.1
AR Points: 0.5

Fossil Fuels — ISBN: 978-0-8368-8399-2
Andrew Solway
Reading Level: 5.5
AR Points: 1.0

Fossil Fuel Power — ISBN: 0-7368-2470-7
Josepha Sherman
Reading Level: 4.9
AR Points: 0.5

**Summary:** How would you summarize your book for another student? Would you recommend it? Why or why not?

# Reading Comprehension Questions

Book Title: _____

Was your book fiction or non-fiction?_____

**Fiction Comprehension Questions**

1. Who is the main character of the story? _____
_____
_____

2. Can you describe the setting? _____
_____
_____

3. What is the main idea of the story? _____
_____
_____

**Non-fiction Comprehension Questions**

1. What is the main idea of the book? _____
_____
_____

2. What is the author's purpose for writing the book? _____
_____
_____

3. List three pieces of information that you have learned from your reading.
_____
_____



# Vocabulary

Biomass - _____

_____

Coal - _____

_____

Energy - _____

_____

Geothermal - _____

_____

Hydropower - _____

_____

Oil - _____

_____

Renewable - _____

_____

Resources - _____

_____

Solar - _____

_____

Vanishing - _____

_____



# Vanishing Resources

**Objective:**
Students will understand the difference between renewable and nonrenewable resources.

**Hypothesis:** What is the difference between renewable and nonrenewable resources?

**Materials:**

- Different colored dried seeds. You can also use legos, coins, etc.
    - For each group
        - 20 - Black beans - Fossil Fuels
        - 5 - Corn - Solar
        - 3 - Pinto Beans - Hydropower/ Geothermal
        - 3 - White beans - Wind
        - 3 - Green peas - Biomass
- Small paper bags (lunch sacks), one per group.

**Procedure:**

1. Place all of the beans and corn into the paper bag.
2. If you are in a group then each person will draw one item from the paper bag (don't peek!). If you are doing this individually then draw out 4 items.
3. Tally your results in a table (attached).
4. If you remove a black bean set it aside; it is a nonrenewable resource and can't be used again. If the items are from renewable sources they can be placed back into the bag.
5. Replay the game until all of the nonrenewable resources have been found.

**Data:** Attached tally sheet.

**Conclusions:**

1. How much oil (black beans) was left after 50 years?
2. Why didn't the solar (corn) energy run out?
3. What energy was used most in the first 10 years? The last 10?
4. What is the difference between renewable and nonrenewable resources?



# Tally Sheet

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Fossil Fuels | | | | | | | | | | |
| Solar | | | | | | | | | | |
| Wind | | | | | | | | | | |
| Hydropower | | | | | | | | | | |
| Biomass | | | | | | | | | | |



# Teacher Resources

**On-line:**
Wikipedia: http://en.wikipedia.org/wiki/Peak_oil
The Energy Story:
http://www.energyquest.ca.gov/story/chapter08.html

**Suggestions**:

1. **Students can be in groups of 3-4; this will minimize supplies and make the activity easier to manage. This activity can take as few as 5 turns or as many as 10, it depends on how you would like to run it.** (The underlying assumption is that we need 4 units of energy per "year." At first they will probably withdraw more fossil fuels than renewable energy but that should shift rather quickly).
2. After the students are finished tallying each year you can go through and find the percentage for each year. Since you are pulling out 4 items at a time it should be easy, each one is just 25%. If that is too advanced for the students you could just talk about half, less than half, more than half.
3. Different groups will come up with different numbers. It may take them 10 tries to find all the black beans, it may only take only three or four times.
4. The coordinator can then record how many tries it took for each group to "run out of" nonrenewable resources. The whole group can then discuss how much longer we have until we run out of oil. (Each turn can represent 10 years and you should have data that stretches from 10 – 100 years.) Each year you should have more energy coming from renewable energy sources
5. Find a Peak Oil graph online and discuss with the students.

# Vanishing Resources Word Search

R A M Q I E R T S V L I J H B
F E G T N V P H K U A G W C I
R O W E Q C P S K E M J Q B O
A E R O S R E S O U R C E S M
G G N N P D D X C G E W U V A
Y U O E M O O Q N N H P P K S
O O S R W L R I F W T V C Y S
A V H L R A H D M M O L H A X
C J F E U S B U Y U E I I C W
M P M P I H R L D H G O B Q T
U K Y N D B U L E S K X C C H
H Z A T R I L Q N K J A E J X
I V N M H M P A B K L Y R Y B
N S P R A L O S O D Q U P P Y
A T C D Q F R P A C D W F R A

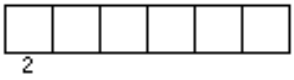
BIOMASS
COAL
ENERGY
GEOTHERMAL
HYDROPOWER
OIL
RENEWABLE
RESOURCES
SOLAR
VANISHING

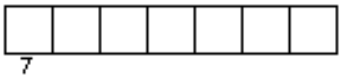
# Vanishing Resources Solution

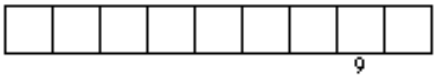
```
R + + + + E + + + + L + + + B
+ E + + N + + + + + A + + + I
R + W E + + + + + + M + + + O
+ E R O + R E S O U R C E S M
+ G N + P + + + + G E + + + A
Y + + E + O + + N + H + + + S
+ + + + W + R I + + T + + + S
+ + + + + A H D + + O L + + +
+ + + + + S B + Y + E I + + +
+ + + + I + + L + H G O + + +
+ + + N + + + + E + + + + + +
+ + A + + + L + + + + + + + +
+ V + + + + + A + + + + + + +
+ + + R A L O S O + + + + + +
+ + + + + + + + + C + + + + +
```

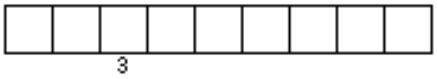
(Over,Down,Direction)
BIOMASS(15,1,S)
COAL(10,15,NW)
ENERGY(6,1,SW)
GEOTHERMAL(11,10,N)
HYDROPOWER(10,10,NW)
OIL(12,10,N)
RENEWABLE(1,3,SE)
RESOURCES(6,4,E)
SOLAR(8,14,W)
VANISHING(2,13,NE)

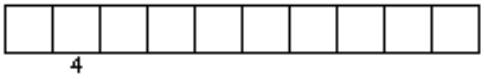
# Vanishing Resources Word Scramble Double Puzzle

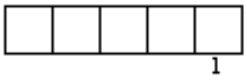
GERYEN 

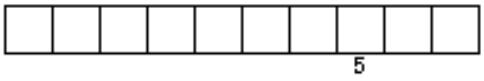

MOSBASI 

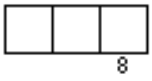

SERCEUSOR 

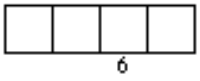

NGNIIVAHS 

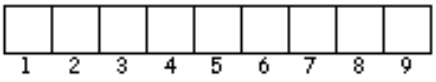

TELRAEMOGH 


OSLRA 


WORPEYHORD 

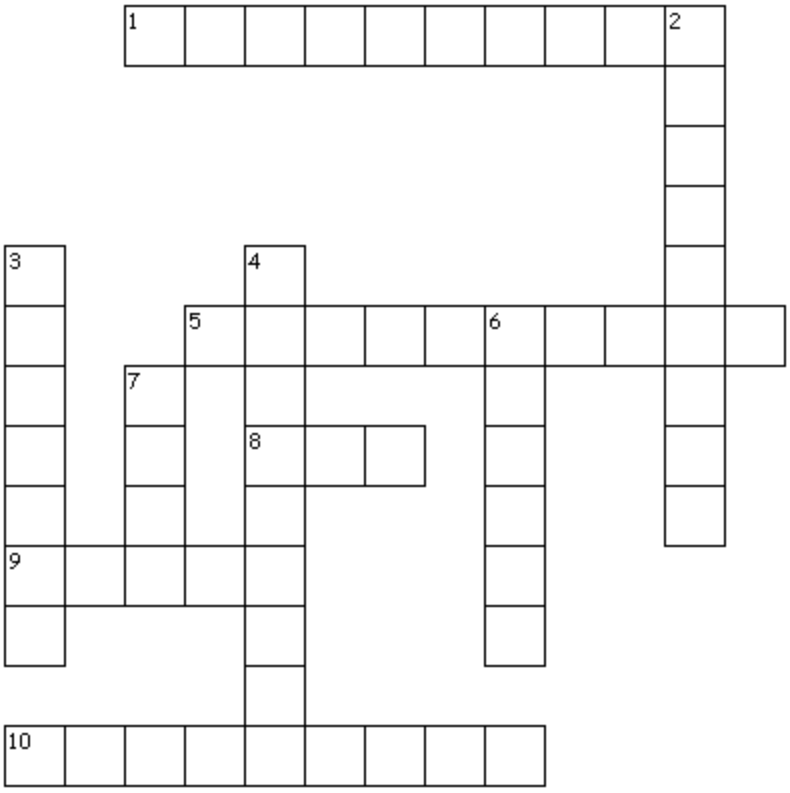

ILO 


LOAC 


Unscramble each of the clue words.
Copy the letters in the numbered cells to other cells with the same number.

# Vanishing Resources Crossword




Across
1. getting energy from the flow of water
5. having to do with the internal heat of the earth
8. greasy, usually liquid substances from plant, animal or mineral sources that are used as lubricants, fuels, and food
9. having to do with the sun
10. to pass from sight or existence

Down
2. being able to use over again
3. organic matter that can be converted to fuel
4. usable stock or supply
6. usable power or resources
7. a black solid mineral

# National Science Content Standards: K-4

## CONTENT STANDARD B, Physical Science:

As a result of the activities in grades K-4, all students should develop an understanding of

### *1. Properties of objects and materials*

a) Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools, such as rulers, balances, and thermometers.

b) Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.

c) Materials can exist in different states--solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling.

### *2. Position and motion of objects*

a) The position of an object can be described by locating it relative to another object or the background.

b) An object's motion can be described by tracing and measuring its position over time.

c) The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.

d) Sound is produced by vibrating objects. The pitch of the sound can be varied by changing the rate of vibration.

### *3. Light, heat, electricity, and magnetism*

a) Light travels in a straight line until it strikes an object. Light can be reflected by a mirror, refracted by a lens, or absorbed by the object.

b) Heat can be produced in many ways, such as burning, rubbing, or mixing one substance with another. Heat can move from one object to another by conduction.

c) Electricity in circuits can produce light, heat, sound, and magnetic effects. Electrical circuits require a complete loop through which an electrical current can pass.

d) Magnets attract and repel each other and certain kinds of other materials.

# DEVELOPING STUDENT UNDERSTANDING

Full inquiry involves asking a simple question, completing an investigation, answering the question, and presenting the results to others.

During their early years, children's natural curiosity leads them to explore the world by observing and manipulating common objects and materials in their environment. Children compare, describe, and sort as they begin to form explanations of the world. Developing a subject-matter knowledge base to explain and predict the world requires many experiences over a long period. Young children bring experiences, understanding, and ideas to school; teachers provide opportunities to continue children's explorations in focused settings with other children using simple tools, such as magnifiers and measuring devices.

Physical science in grades K-4 includes topics that give students a chance to increase their understanding of the characteristics of objects and materials that they encounter daily. Through the observation, manipulation, and classification of common objects, children reflect on the similarities and differences of the objects. As a result, their initial sketches and single-word descriptions lead to increasingly more detailed drawings and richer verbal descriptions. Describing, grouping, and sorting solid objects and materials is possible early in this grade range. By grade 4, distinctions between the properties of objects and materials can be understood in specific contexts, such as a set of rocks or living materials.

Young children begin their study of matter by examining and qualitatively describing objects and their behavior. The important but abstract ideas of science, such as atomic structure of matter and the conservation of energy, all begin with observing and keeping track of the way the world behaves. When carefully observed, described, and measured, the properties of objects, changes in properties over time, and the changes that occur when materials interact provide the necessary precursors to the later introduction of more abstract ideas in the upper grade levels.

As children develop facility with language, their descriptions become richer and include more detail. Initially no tools need to be used, but children eventually learn that they can add to their descriptions by measuring objects--first with measuring devices they create and then by using conventional measuring instruments, such as rulers, balances, and thermometers. By recording data and making graphs and charts, older children can search for patterns and order in their work and that of their peers. For example, they can determine the speed of an object as fast, faster, or fastest in the earliest grades. As students get older, they can represent motion on simple grids and graphs and describe speed as the distance traveled in a given unit of time.