Teacher Guide

Background

Intermediate Energy Infobook Activities is a series of student worksheets designed to reinforce the vocabulary, concepts, and information in the Intermediate Energy Infobook. You can download the *Intermediate Energy Infobook* or specific energy infosheets from www.NEED.org/Energy-Infobooks.

Time

Approximately 30-45 minutes for the students to read each selected infosheet and complete the worksheets.

Skills

- Nonfiction Reading
- Critical Thinking
- Vocabulary
- Graphing

Preparation

- Decide which infosheets and worksheets you will use with your class.
- Obtain a class set of *Intermediate Energy Infobooks* or make copies of the infosheets you plan to use.
- Make copies of the student worksheets you plan to use from this booklet.
- *Energy in the Balance* contains charting and graphing activities to further reinforce the information in the infobooks. Many other NEED activities also reinforce and synthesize the information in the infobooks, such as *Energy Jeopardy*, *Great Energy Debate*, *Transparent Energy*, *Energy on Stage*, *Great Energy Rock Performances*, *Energy Expo,* and the *Energy Carnival*.

Procedure

1. Distribute one *Intermediate Energy Infobook* to each student.
2. Have the students read the selected infosheet. Discuss the concepts and new vocabulary in the infosheet.
3. Have the students complete the selected worksheets.
4. Once students have read all of the energy source infosheets and completed the worksheets for each source, have the students complete the worksheets on pages 23-25 of this booklet. These worksheets reinforce and synthesize the information in the source infosheets. Pages 26-30 are worksheets for the Electricity infosheets. All infosheets can be found in the Intermediate Energy Infobook.
5. Critical Thinking Questions are included on page 6. You may choose to use any or all questions with your students,
6. Use the *Evaluation Form* on page 43 to evaluate the activities, then mail or fax back to NEED.

Answers to Critical Thinking Questions

1. **Explain five transfers of energy that are happening right now in your classroom.**
   Answers may include: electrical to sound (radio, bell, tv), chemical to motion (food digesting in their stomachs), radiant to heat (students sitting near the window feeling warm)…
2. **Write a persuasive letter to a town council about the pros and cons of a new landfill.**
   Answers may include: Negative – smell, smoke from burning garbage; Positive – cheaper power, cheaper garbage pickup
3. **Do you think people mining for coal should have to use reclamation on the land? Why or why not?**
   Answer: Students should pick yes or no, and explain why the land should be taken care of after it has been used for mining or why it should not.
4. **Rank the layers of the earth in order of importance. Give reasons why you ranked them in that order.**
   Answer: Students should order the layers (core, mantle, crust) and defend why they put them in that order.
5. **Write a debate between an environmentalist who is worried about the construction of a hydropower plant and the plant owner.**
   Answers may include the environmentalist being worried about flooding the area and the loss of animals and habitat. The plant owner may state that the reservoir will provide recreational options and that salmon ladders and other things can be built to protect the wildlife. They may also mention that the area needs a cheap, clean power source, and the dam will provide that.
6. **Compare how sectors use natural gas to how they use other sources. What does natural gas have in common with other sources? What is unique about it? What generalizations can you make about natural gas after looking at the data?**
   Answers may include that it is split between [commercial, residential, industrial, transportation, and electricity] like some other sources (biomass and petroleum). Unlike the others, natural gas does not have a sector that dominates its resources. This could mean that natural gas is more versatile than the other sources.
7. **Describe one benefit and one challnge of U.S. petroleum consumption.**
   Answer: Answers will vary but benefits may include that petroleum fuels our society allowing us to travel easily, or that petroleum is an inexpensive transportation fuel compared to many alternative fuels. Challenges may include that we consume more petroleum than we produce or that burning petroleum releases carbon dioxide.
8. **Fleet vehicles and machinery that is used indoors often use propane. Why do you think these vehicles (more than others) are likely to use propane instead of petroleum?**
   Answers may include that indoor vehicles don't want any form of exhaust that would come with a petroleum vehicle since they are trapped indoors. Fleet vehicles are able to use propane since they have set routes or a set location they remain in. They are able to access propane filling areas. Other vehicles would have more trouble with it since there are not many propane filling stations.
9. **Do you think the sun's light or heat are more important? Explain your answer.**
   Answer: Students should clearly identify one or the other and justify their answer with reasoning.
10. **Many energy sources can be dangerous if not captured, used, or contained properly. Make a list of problems that can arise through the use of uranium and solutions that can be used to prevent the problems from occurring.**
11. **If a 10 turbine wind farm was going to be placed somewhere in your community, where do you think the ideal site would be? Explain the reason you picked that site. Also include 5 sites you considered but rejected and the reasons you rejected them.**
    Answers should include that the area needs to be big enough to support 10 turbines. The turbines should be the tallest thing around, so the wind is not blocked. The area underneath could be used for farmland or grazing land, [but should not otherwise be used.] The area must have strong, steady winds. There should not be any bird migration or bird nesting sites in the immediate vicinity.
12. **Summarize what this chart shows you about our use of renewable and nonrenewable resources.**
    Students summary might include the fact that we use 92% nonrenewable sources, that we use more uranium (or coal or petroleum or natural gas) than we do of all the renewables combined, that the renewables are only a small piece of the pie…
13. **Add another 5 words that have to do with electricity to the electricity crossword. They need to appropriately connect to the current puzzle. Write clues that would help someone figure out your words.** Answers will vary.
14. **When we flip a switch, our lights go on. When we plug something in, and turn it on, it works. We don't think about where this energy, electricity, comes from. Pretend you are a spark of electricity. Explain your journey from an energy resource to your Wii console.**
    Students may identify the energy resource they begin as (uranium, coal…). Students may explain how that resource turns into electricity. They should trace the path from the power plant to the transformer, the transmission lines, the neighborhood transformer, the distribution line, a small transformer, and finally wires into the walls in the house. There is a diagram on p 29 that will help with some of this.

Biomass

Description of biomass:
Any organic material that can be used for its energy content – woods garbage, yard waste, crop waste, animal waste, even human waste.

Renewable or nonrenewable:
Renewable

Ways we turn biomass into energy we can use:
Burning to produce heat, fermentation into alcohol fuel (ethanol), bacterial decay into methane, conversion to gas or liquid fuels by addition of heat or chemicals.

Who uses biomass and for what purposes:
Industry burns waste wood to make products, homes burn wood for heat, waste-to-energy plants burn organic waste products to produce electricity, gasohol is used as a fuel.

Effect of using biomass on the environment:
Burning biomass can produce air pollution and it can also produce odors. Burning biomass is cleaner than burning fossil fuels.

Important facts about biomass:
Biomass gets its energy from the sun through the process of photosynthesis.

Using biomass reduces the amount of organic material placed in landfills.

Fast-growing crops can be grown for their energy content.

Using biomass does not contribute to the greenhouse effect, since the amount of carbon dioxide produced equals the amount taken in during growth.

Coal

Description of coal:
Coal is a black, solid hydrocarbon (fossil fuel) formed from the remains of ancient plants in swamps millions of years ago.

Renewable or nonrenewable:
Nonrenewable

Where coal is located and how we recover it:
Coal is located underground in many areas of the country. Shallow seams are surface mined. Coal buried deep is reached through underground mine shafts.

Ways we turn coal into energy we can use:
Most coal is burned to produce heat.

Who uses coal and for what purposes:
Power plants burn most of the coal to produce electricity. Industries also burn coal to make products, especially steel and iron.

Effect of using coal on the environment:
Burning coal can pollute the air and cause acid rain. Burning coal also produces carbon dioxide, a greenhouse gas.

Important facts about coal:
Coal produces nearly half of the electricity in the U.S.

The U.S. has the largest reserves of coal in the world.

Coal is found in Appalachian states and some western states.

Wyoming, West Virginia, Kentucky, Pennsylvania, and Montana are the top coal-producing states.

Coal is transported mainly by train and barge. Transporting coal is a huge expense.

Geothermal Energy

Description of geothermal energy:
Geothermal energy is heat produced in the earth's core by the slow decay of naturally-occurring radioactive particles.

Renewable or nonrenewable:
Renewable

Where geothermal resources are located and how we recover them:
Low temperature resources are almost everywhere a few feet underground. High temperature resources are found mostly at the edges of tectonic plates, especially around the Ring of Fire in the Pacific.

Ways we turn geothermal energy into energy we can use:
We can drill wells to reach high temperature resources or lay pipes filled with fluid underground. Some geothermal resources come out of the ground naturally, and we can pipe it to where it's needed.

Who uses geothermal energy and for what purposes:
Power plants use geothermal steam to produce electricity. Homes and businesses use the hot water and steam for heat.

Effect of using geothermal energy on the environment:
There is very little environmental effect.

Important facts about geothermal energy:

Earth is made of layers – an inner core of iron, an outer core of magma (melted rock), a mantle of magma and rock, and a crust. The crust is not a solid piece, but giant plates of land that move. Along the edges of the plates, geothermal resources tend to come to the surface.

Hydropower

Description of hydropower:
Hydropower is the force of moving water caused by gravity.

Renewable or nonrenewable:
Renewable

Description of the water cycle:
The sun shines onto the Earth, evaporating the water in oceans, rivers, and lakes. The water vapor rises into the atmosphere and forms clouds. The water vapor condenses and falls to Earth as precipitation.

Ways we turn hydropower into energy we can use:
We can harness the energy in flowing water by damming rivers and using waterfalls.

Who uses hydropower and for what purposes:
Electric utilities use hydropower dams to turn the energy in flowing water into electricity.

Effect of using hydropower on the environment:
Dams can flood land and disrupt animal and fish habitats. Hydropower doesn't pollute the air, but it can churn up sediments in the water.

Important facts about hydropower:
Hydropower dams are the cheapest and cleanest way to produce electricity.

There are few places in the U.S. where new dams can be built.

Some existing dams could have turbines installed to produce electricity.

Natural Gas

Description of natural gas:
Natural gas is a colorless, odorless gas formed millions of years ago from tiny plants and animals. It is a fossil fuel.

Renewable or nonrenewable:
Nonrenewable, although methane produced from landfill gas is classified as renewable

Where natural gas is located and how we recover it:
Natural gas is located in underground rock formations in sedimentary basins. We drill wells to reach it and pipe it from the ground.

Ways we turn natural gas into energy we can use:
Usually we burn natural gas to produce heat.

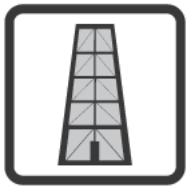
Who uses natural gas and for what purposes:
Industry burns natural gas to manufacture products. Homes and businesses burn natural gas to heat buildings and water, and for cooking. Power plants burn natural gas to produce electricity.

Effect of using natural gas on the environment:
Natural gas is a cleaner burning fossil fuel, but it produces some air pollution and carbon dioxide, a greenhouse gas.

Important facts about natural gas:
Mercaptan, an odorant that smells like rotten eggs, is added to natural gas so leaks can be detected.

Natural gas is shipped by millions of miles of underground pipelines.

Natural gas can be used as a transportation fuel if it is put under pressure and engines are modified.



Petroleum

Description of petroleum:
Petroleum is a liquid hydrocarbon, a fossil fuel formed millions of years ago from the remains of tiny sea plants and animals. It can be thin and clear like water or thick and black like tar.

Renewable or nonrenewable:
Nonrenewable

Where petroleum is located and how we recover it:
Petroleum is located underground in rocks in sedimentary basins. Much is under water. We drill wells to find it, then must pump it from the ground.

Ways we turn petroleum into energy we can use:
Petroleum is refined into many different fuels that are burned to produce heat. When gasoline is burned in vehicles, it causes small explosions that push pistons to produce motion.

Who uses petroleum and for what purposes:
Most petroleum products are used by the transportation sector to move people and goods. Industry burns petroleum to manufacture products and also uses petroleum as a feedstock to produce many products.

Effect of using petroleum on the environment:
Burning petroleum can cause air pollution and produce carbon dioxide, a greenhouse gas. Drilling for and transporting petroleum can cause damage to the land and water if there are leaks or spills.

Important facts about petroleum:
We use more petroleum than any other energy source.

The U.S. does not produce enough petroleum to meet our needs.

We import about half of the petroleum we use from foreign countries.

The Middle East has huge reserves of petroleum.

Petroleum is moved over land mostly by pipeline, and over water by tanker.

Propane

Description of propane:
Propane is a colorless, odorless fossil fuel found with petroleum and natural gas. It was formed millions of years ago from the remains of tiny plants and animals.

Renewable or nonrenewable:
Nonrenewable

Where propane is located and how we recover it:
Propane is found with petroleum and natural gas deposits and is separated from both fuels during refining and processing.

Ways we turn propane into energy we can use:
We put propane in tanks under pressure to turn it into a liquid so that it is more easily moved from place to place, then we burn it to produce heat.

Who uses propane and for what purposes:
Industry uses propane to make products; farmers use propane for heat in rural areas; homes use propane for outdoor grills; businesses use propane to fuel indoor machinery and as a fleet fuel.

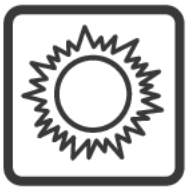
Effect of using propane on the environment:
Propane is a cleaner burning fossil fuel, but burning it does produce some air pollutants and carbon dioxide, a greenhouse gas.

Important facts about propane:
Propane is an LPG – liquefied petroleum gas.

Propane is easily turned into a liquid under pressure. It takes up 270 times less space as a liquid.

Propane is stored in underground caverns and moved by pipelines and trucks.

Propane is called a portable fuel because it is easily transported as a liquid.



Solar Energy

Description of solar energy:
Solar energy is radiant energy from the sun that travels to Earth in electromagnetic waves or rays.

Renewable or nonrenewable:
Renewable

How solar energy is produced and how we recover it:
Solar energy is produced in the sun's core when atoms of hydrogen combine under pressure to produce helium, in a process called fusion. During fusion, radiant energy is emitted.

Ways we turn solar into energy we can use:
We can capture solar energy with solar collectors that turn the radiant energy into heat, or with photovoltaic cells that turn radiant energy into electricity. We also use the visible light of solar energy to see.

Who uses solar and for what purposes:
We all use the visible light from the sun to see during the day. Many homes and buildings use solar collectors to heat interior spaces and water, and PV cells to produce electricity.

Effect of using solar on the environment:
Solar energy is very clean energy, producing no air or water pollution.

Important facts about solar:
Solar energy is not available all of the time and is spread out so that it is difficult to harness. Today, it is expensive to use solar energy to produce electricity, but new technologies will make solar energy a major energy source in the future.

Uranium

Description of uranium:
Uranium is a common metallic element found in rocks all over the world.

Renewable or nonrenewable:
Nonrenewable

Where uranium is located and how we recover it:
Uranium is located underground in rock formations. Mines are dug to recover it. The U.S. has plenty of uranium, but imports most used in nuclear power plants because it is cheaper to do so.

Ways we turn uranium into energy we can use:
Uranium is processed and turned into uranium fuel pellets for nuclear power plants. Uranium atoms are split in the process of fission to produce heat.

Who uses uranium and for what purposes:
Nuclear power plants use uranium to produce electricity.

Effect of using uranium (nuclear energy) on the environment:
Uranium fission produces radioactive wastes that is dangerous for thousands of years and must be stored carefully. Leaks of radioactive materials pose a danger.

Important facts about uranium (nuclear energy):
Nuclear power plants produce little pollution except for radioactive waste, which must be stored in special repositories. There is no permanent repository in the United States at this time and most waste is stored on site at nuclear power plants. A permanent repository is mandated by Congress, but a final location has not been chosen.

Wind

Description of wind energy:
Wind is the circulation of air caused by the uneven heating of Earth's surface.

Renewable or nonrenewable:
Renewable

Where wind energy is located and how we recover it:
Wind is produced when the sun shines on the Earth, heating the land more than the water. The warmer air over land rises and cooler air moves in to take its place, producing convection currents.

Ways we turn wind into energy we can use:
We use wind turbines that have blades, which turn in the wind that turn a turbine to produce electricity.

Who uses wind and for what purposes:
Usually, independent power producers (not big utilities) build wind farms to produce electricity.

Effect of using wind on the environment:
Wind turbines are very clean, producing no air or water pollution. They take up a lot of land, but most of the land can be used for other things, such as farming and grazing cattle, at the same time.

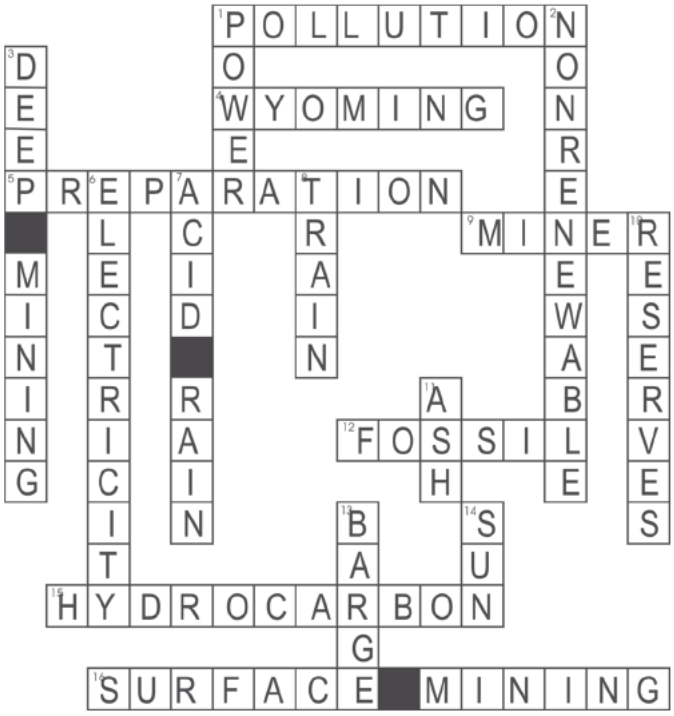
Important facts about wind:
Wind turbines do not produce a lot of electricity, and do not produce it all of the time.

Wind turbines cannot be used in many areas. There must be stable, continuous wind resources.

There are large wind resources over the ocean. The first offshore wind farm in the United States was approved in 2011 and will be built off the coast of Cape Cod, MA.

Biomass Crossword Answers

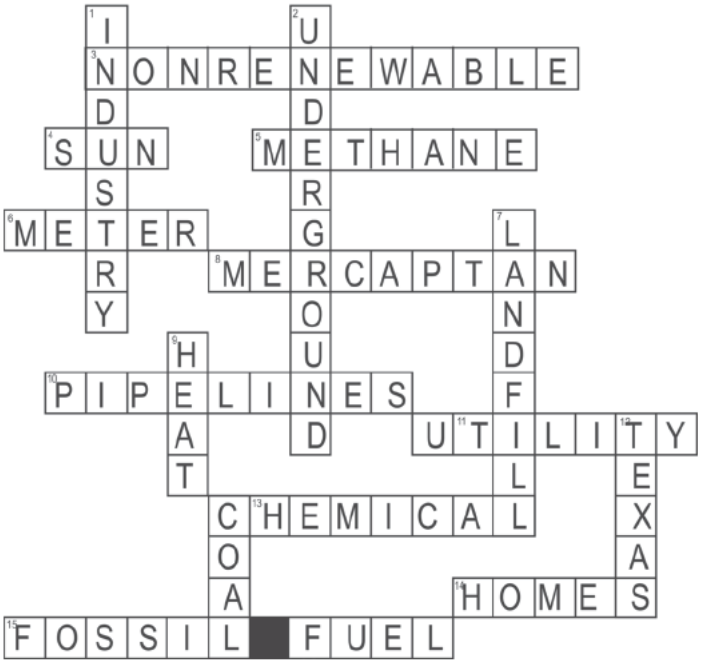
Coal Crossword Answers



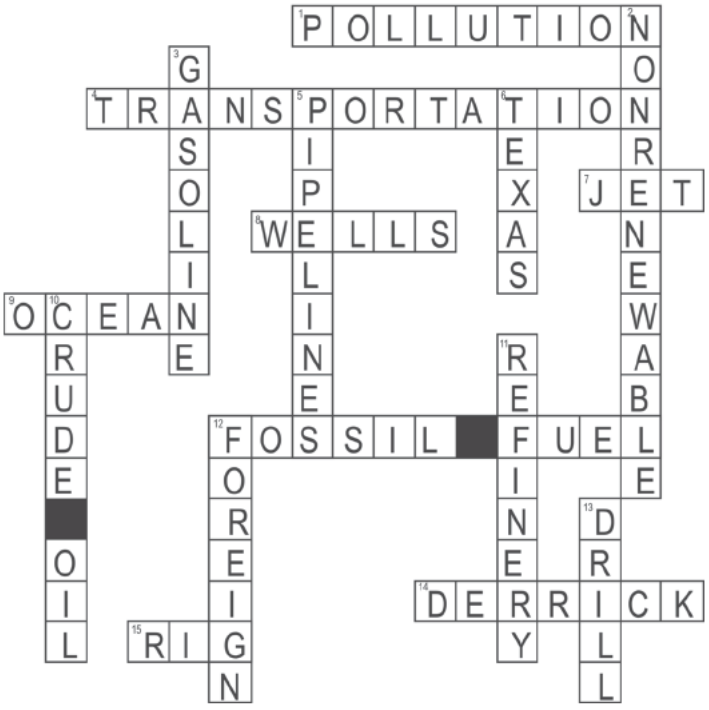
Geothermal Crossword Answers

Hydropower Crossword Answers

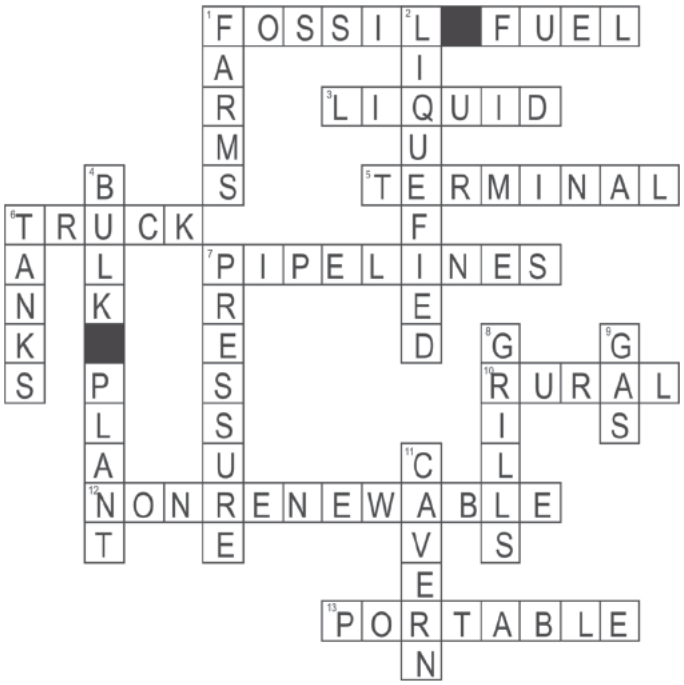
Natural Gas Crossword Answers



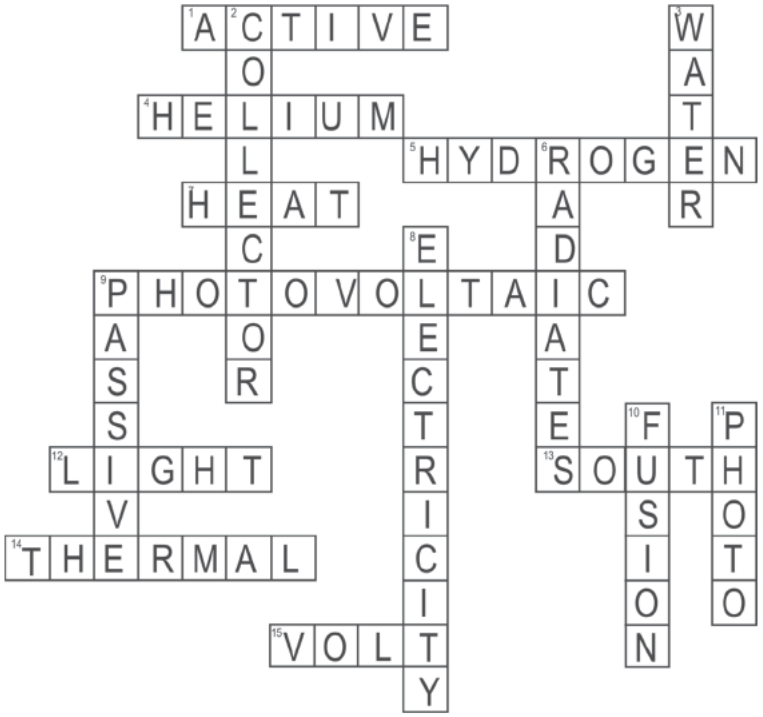
Petroleum Crossword Answers



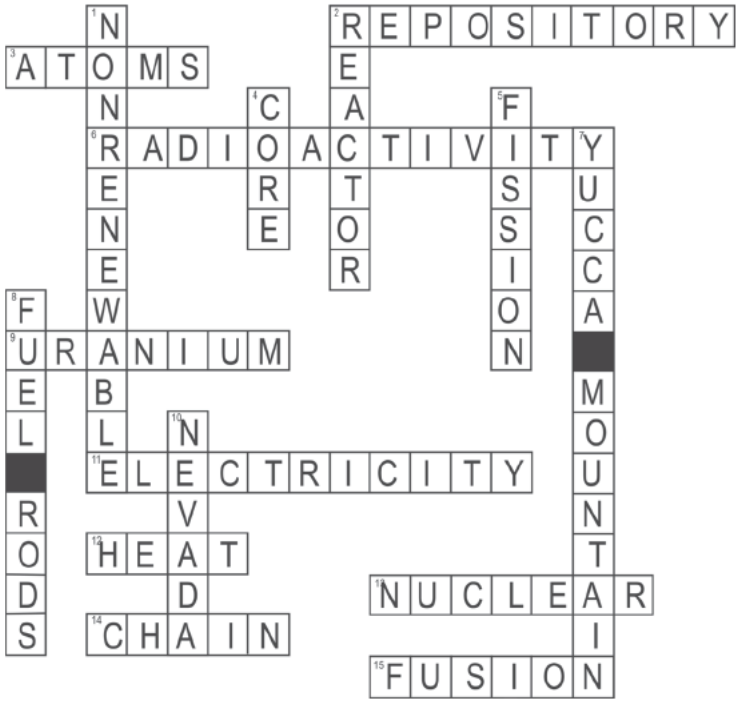
Propane Crossword Answers



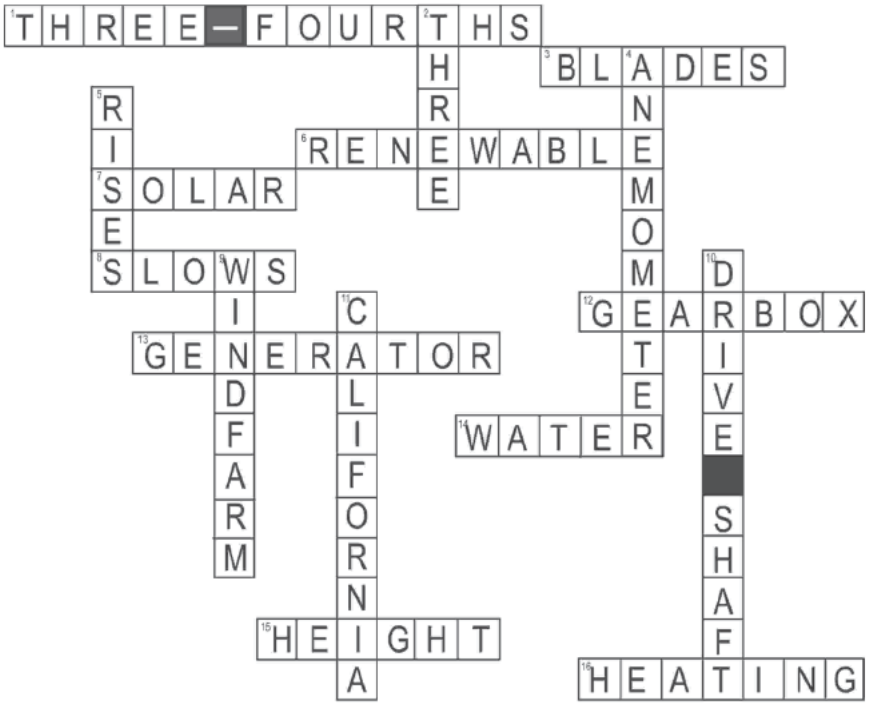
Solar Crossword Answers



Uranium Crossword Answers



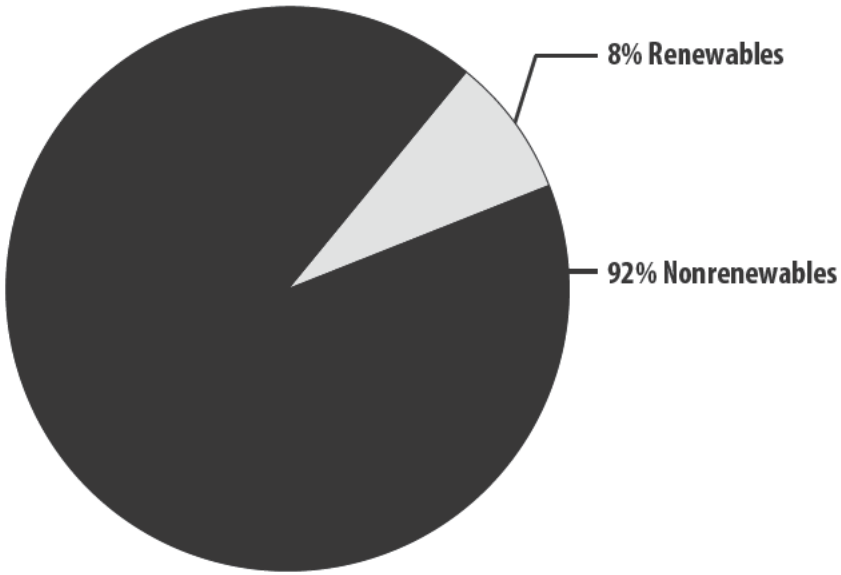
Wind Crossword Answers



Renewables and Nonrenewables

Convert the quads into percentagse and make a pie chart showing how much U.S. energy in 2009 came from renewable sources and how much came from nonrenewable sources (Q = quad or quadrillion Btu). Round to the nearest tenth.

Petroleum	34.49 Q	= 36.5 %
Natural Gas	23.36 Q	= 24.7%
Coal	19.76 Q	= 20.9 %
Uranium	8.35 Q	= 8.8 %
Biomass	3.88 Q	= 4.1 %
Hydropower	2.68 Q	= 2.8 %
Geothermal, Solar, and Wind	1.18 Q	= 1.2 %
Propane	1.0 Q	= .9%



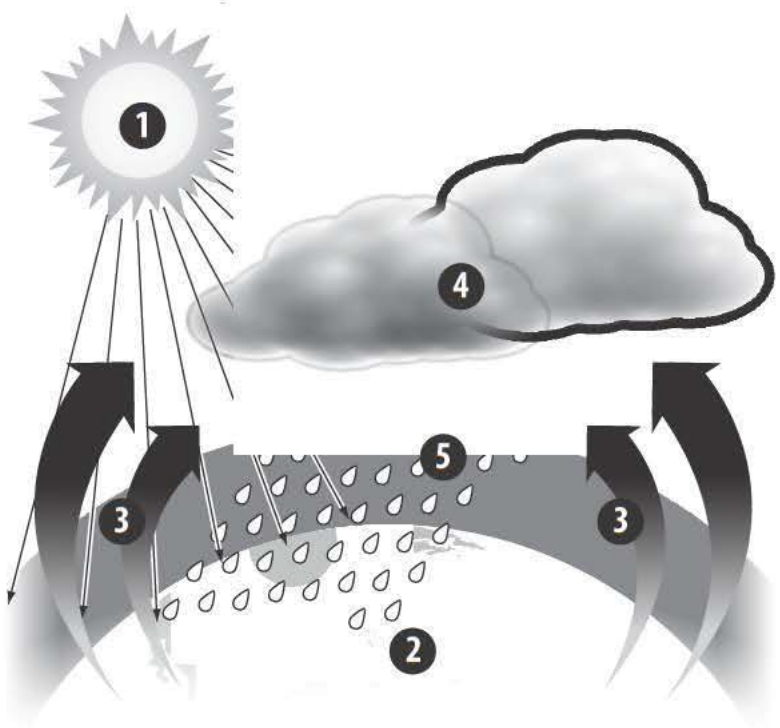
How We Use Our Energy Sources

In the boxes, number the main uses of each energy source from 1 to 5 with 1 as the most important use. Some sources may be used in only one or two ways.

	TRANSPORTATION	MAKE PRODUCTS	HEATING/COOLING	LIGHTING	MAKE ELECTRICITY
	4	1	2	5	3
		2			1
			1		2
					1
	4	1	3		2
	1	2	3		4
	3	1	2		
			2	1	3
					1
					1

The Water Cycle

Label and describe the water cycle in the space below following the numbers on the diagram.



1. The sun shines radiant energy onto the Earth. When it hits objects, some of the radiant energy is converted into heat.
2. The heat warms and evaporates water in oceans and rivers.
3. The water vapor rises into the atmosphere.
4. The water vapor forms clouds in the atmosphere.
5. The water vapor in the clouds condenses and falls to Earth as precipitation.

Electricity

Write the correct word for each definition in the blank space. Use each word only once.

1. A substance in which all atoms are identical. *element*
2. The center of an atom. *nucleus*
3. The negatively-charged particle of an atom. *electron*
4. The positively-charged particle of an atom. *proton*
5. The particle in the nucleus of an atom with no charge. *neutron*
6. The smallest part of an element that retains the element's characteristics. *atom*
7. An electrical force within an atomic particle. *charge*
8. The areas around the nucleus where electrons are located. *energy levels*
9. The force filed created between the poles of a magnet. *magnetic field*
10. A device that does work in an electrical circuit. *load*
11. A path through which electricity travels. *circuit*
12. An object in which the electrons at one end spin in one direction and the electrons at the other end spin in an opposite direction. *magnet*
13. How like charges or magnetic poles respond. *repel*
14. A device with magnets and coils of wire that produces electricity. *generator*
15. A device that produces electricity through a chemical reaction. *battery*

Word Bank

- nucleus
- atom
- element
- proton
- neutron
- electron
- shells
- static
- load
- turbine
- generator
- magnetic field
- magnet
- circuit
- battery
- attract
- repel
- charge

Electricity Crossword

						1 S	E	C	O	N	D	A	R	Y
						U								
			3 W			B		5 C						
2 T	R	A	N	S	4 M	I	S	S	I	O	N			
			T		A		T			A				
			T		G		A			L				
					N		T					8 G		
					E		I					E		
6 K	I	L	O	W	A	7 T	T	H	O	U	R			N
						U			N					E
					9 T	R	A	N	S	F	O	R	M	E	R
						B								A
			10 D	I	S	T	R	I	B	U	T	I	O	N
						N								O
			11 E	F	F	I	C	I	E	N	C	Y		R

Famous Words Answer Key

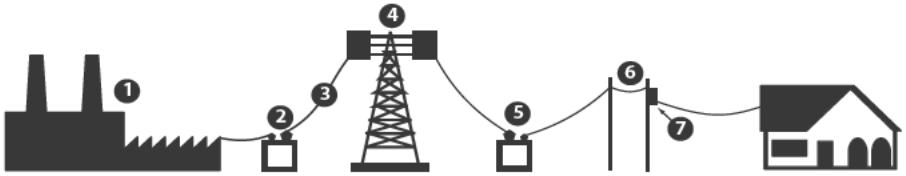
1. Faraday
2. Westinghouse
3. Franklin
4. Volta
5. Edison
6. Niagara Falls

Electric Math Answer Key

Left Column: 120, 12 ,35, 1879, 1000, 1882
Right Column: 10, 350, 2229, 2.2, 4195.0

Transporting Electricity

Explain what each of the components numbered below does to get electricity from the generator to the consumer.



1. **Power plant:** *generates electricity*
2. **Step-up transformer:** *increase voltage to reduce transmission loss*
3. **Transmission line:** *transports high-voltage electricty over long distances*
4. **Power tower:** *carries transmission lines*
5. **Step-down transformer:** *lowers voltage for smaller distribution lines*
6. **Distribution line:** *carries lower voltage electricty to homes and businesses*
7. **Neighborhood transformer:** *lowers voltage used by appliances in homes and businesses (120 & 140 volts)*

Measuring Electricity

Directions: Fill in the blanks in the tables below.

TABLE 1

VOLTAGE	=	CURRENT	X	RESISTANCE
1.5 V	=	**0.5 A**	x	3 Ω
12 V	=	3 A	x	4 Ω
120 V	=	4 A	x	**30 Ω**
240 V	=	**20 A**	x	12 Ω

TABLE 2

POWER	=	VOLTAGE	X	CURRENT
27 W	=	9 V	x	**3 A**
180 W	=	120 V	x	1.5 A
45 W	=	**15 V**	x	3 A
240 W	=	120 V	x	2 A

TABLE 3

APPLIANCE		POWER	=	VOLTAGE	X	CURRENT
TV		180 W	=	120 V	x	**1.5 A**
COMPUTER		40 W	=	120 V	x	**0.33 A**
PRINTER		120 W	=	120 V	x	**1 A**
HAIR DRYER		1,000 W	=	120 V	x	**8.33 A**

TABLE 4

POWER		TIME	=	ELECTRICAL ENERGY (kWh)	X	PRICE	=	COST
5 kW	x	100 h	=	**500 kWh**	x	$ 0.12	=	**$ 60.00**
25 kW	x	4 h	=	**1000 Wh = 1kWh**	x	$ 0.12	=	**$ 0.12**
1,000 W	x	1 h	=	**100 kWh**	x	$0.12	=	**$ 12.00**

Forms of Energy Answers

Fill in the blanks with the words at the bottom of the page. You can use words more than once.

1. Stored energy and the energy of position are **potential** energy.
2. Compressed springs and stretched rubber bands are stored **mechanical** energy.
3. The vibration and movement of the atoms and molecules within substances is called heat or **thermal** energy.
4. The scientific rule that states that energy cannot be created or destroyed is called the Law of **Conservation of Energy**.
5. The movement of energy through substances in longitudinal waves is **sound**.
6. The energy of position – such as a rock on a hill – is **gravitational** energy.
7. The movement of objects and substances from place to place is **motion**.
8. Electromagnetic energy traveling in transverse waves is **radiant** energy.
9. Energy stored in the bonds of atoms and molecules is **chemical** energy.
10. The movement of atoms, molecules, waves, and electrons is **kinetic** energy.
11. The movement of electrons is **electrical** energy.
12. The amount of useful energy you get from a system is its **energy efficiency**.
13. The energy in petroleum and coal is stored as **chemical** energy.
14. X-rays are an example of **radiant** energy.
15. Fission and fusion are examples of **nuclear** energy.
16. A hydropower reservoir is an example of **gravitational** energy.
17. Wind is an example of the energy of **motion**.

Word Bank

- chemical
- conservation of energy
- electrical
- energy efficiency
- gravitational
- kinetic
- mechanical
- motion
- nuclear
- potential
- radiant
- sound
- thermal