



Science and Technology

CRITICAL THINKING

categorizing information

READING

understanding comparisons and contrasts

VOCABULARY

using the dictionary to distinguish
between homonyms

WRITING

writing a compare and contrast essay

GRAMMAR

subordinators and transitions to compare
and contrast



UNIT QUESTION

How can science improve lives?

A. Discuss these questions with your classmates.

1. Have you experienced a time without electricity? How did it affect your activities?
2. Which electronic device (an object or piece of equipment) would you miss the most if you didn't have it?
3. Look at the photo. What might the device do? How could it improve people's lives?



B. Listen to *The Q Classroom* online. Then answer these questions.

1. Marcus focuses on technology as one way that science can improve lives. What does Sophy focus on in her answer?
2. Yuna thinks that science sometimes doesn't help us and gives examples of air and water pollution. What is Felix's response to Yuna?

iQ PRACTICE Go to the online discussion board to discuss the Unit Question with your classmates. *Practice > Unit 4 > Activity 1*

UNIT OBJECTIVE

Read a product review and a news article. Gather information and ideas to write an essay comparing and contrasting two new technologies that can improve lives.

READING 1

Five Innovative Technologies That Bring Energy to the Developing World

OBJECTIVE ▶

You are going to read a product review by Joseph Stromberg for Smithsonian.com. The review looks at innovative energy technologies. Use the review to gather information and ideas for your Unit Assignment.

PREVIEW THE READING

- A. PREVIEW** Read the title. Read the headings and look at the pictures.
1. Try to guess what the five technologies are from their names and pictures.
 2. Which of the five technologies seems most interesting? Why?
- B. QUICK WRITE** Imagine your life without electricity. How would it be different than your life with electricity? Compare the two. Write for 5–10 minutes in response. Remember to use this section for your Unit Assignment.
- C. VOCABULARY** Check (✓) the words you know. Use a dictionary to define any new or unknown words. Then discuss with a partner how the words will relate to the unit.

alleviate (v.)
 dedicated (adj.) **U+**
 developing (adj.)
 enterprise (n.) **U+**
 existence (n.) **U+ OPAL**
 generate (v.) **U+ OPAL**

grid (n.) **U+**
 innovative (adj.) **U+**
 intuitively (adv.)
 motion (n.) **U+**
 replacement (n.) **U+ OPAL**
 resemble (v.) **U+**

U+ Oxford 5000™ words

OPAL Oxford Phrasal Academic Lexicon

iQ PRACTICE Go online to listen and practice your pronunciation.
 Practice > Unit 4 > Activity 2

WORK WITH THE READING



A. **INVESTIGATE** Read the review and gather information about innovative energy technologies.



FIVE INNOVATIVE TECHNOLOGIES THAT BRING ENERGY TO THE DEVELOPING WORLD

By Joseph Stromberg

- 1 In the wealthy world, improving the energy system generally means increasing the central supply of reliable, inexpensive, and environmentally-friendly power. This power is then distributed through the power **grid**. Across most of the planet, though, millions of people are without electricity and depend on burning wood or kerosene¹ for heat and light. Simply providing new energy sources would open up new opportunities for these people and for engineers and designers.
- 2 With that in mind, engineers and designers have recently created a range of **innovative** devices that can increase the supply of safe, cheap energy on a user-by-user basis. The devices do not need the years it takes to extend the power grid to remote places. They also make it easier for countries to produce more energy without spending a lot more money. Here are a few of the most promising technologies.

VOTO

Like Comment

- 3 Millions of people around the world use charcoal² and wood-fueled stoves on a daily basis. VOTO, developed by the company Point Source Power, converts the energy these fires release as heat into electricity. That electricity can power a handheld light, charge a phone, or even charge a spare battery. The company initially designed VOTO for backpackers and campers in wealthy countries, so they can charge their devices during trips. Now it is also trying to find a way for residents of the **developing** world to use it every day.

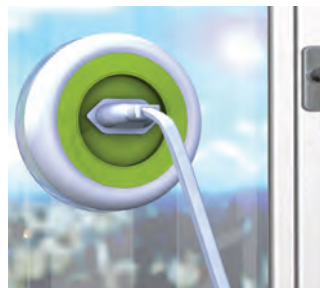


VOTO

The Window Socket

Like Comment

- 4 This is perhaps the simplest solar charger in **existence**. Just stick it on a sunny window for 5–8 hours, with the built-in suction cup³. The solar panels on the back will store about ten hours' worth of electricity that can be used with any device. If there's no window available, a user can just leave it on any sunny surface, including the ground. Once it's fully charged, it can be removed and taken anywhere. It can be stored in a bag or carried around in a vehicle. The designers, Kyuho Song and Boa Oh of Yanko Design, created it to **resemble** a normal wall outlet⁴ as closely as possible. In that way, it can be used **intuitively** without any special instructions.



The Window Socket

¹ **kerosene**: a type of fuel oil made of petroleum and that is used for heat and light

² **charcoal**: a black substance made by burning wood slowly in an oven with little air; used as a fuel

³ **suction cup**: a cup-shaped device that produces a partial vacuum that makes it stick to a surface

⁴ **wall outlet**: a device in a wall that you plug into to connect electrical equipment

The Berkeley-Darfur Stove

Like Comment

5 In the past few years, a number of health researchers have come to the same conclusion: Providing a safe, energy-efficient, wood-burning cookstove to millions of people in the developing world has three major benefits. This kind of cookstove can directly improve health by reducing smoke inhalation⁵. It can aid the environment by reducing the amount of wood needed for fuel. It can **alleviate** poverty by reducing the amount of time needed to devote to gathering wood every day.



The Berkeley-Darfur Stove

6 Many projects have pursued this goal. Potential Energy, a nonprofit **dedicated** to adapting technologies to help improve lives in the developing world, is the furthest along. Potential Energy has distributed more than 25,000 of their Berkeley-Darfur Stoves in Darfur and Ethiopia. Their stove's design achieves these aims with features such as a wind collar that keeps the fire from burning too fast and air vents that reduce the amount of wind allowed to affect the fire, which decreases the amount of fuel wasted. It also has ridges that let the cook pot be at the best distance from the fire in order to use the fuel in the most efficient manner.

The GravityLight

Like Comment

7 Kerosene-burning lamps provide light throughout the developing world. However, these lamps are targets for **replacement** because the fumes⁶ **generated** by burning kerosene in close quarters are a major health problem. A seemingly simple solution is GravityLight, developed by deciwatt.org.



The GravityLight

8 To power the device, a user fills an included bag with about 20 pounds of rock or dirt. He or she attaches it to the cord hanging down from the device and lifts it upward. The potential energy stored in that lifting **motion** is then gradually converted to electricity by the GravityLight. It slowly lets the bag downward over the course of about 30 minutes and powers a light or other electrical device during that time. It's currently priced at about \$10. Because it requires no cost to run, the development team estimates that the cost to buy it will be paid back in about three months by saving the money used to buy kerosene.

SOCCKET

Like Comment

9 Soccer is easily the most popular sport in the world. The newest product of Uncharted Power, a for-profit social **enterprise**, seeks to take advantage of the millions of people already playing the sport. Uncharted Power wants to replace kerosene lamps with electric light that is generated in a much different manner. Their ball uses an internal motion-powered device to generate and store electricity. After about 30 minutes of play, the ball stores enough energy to power an attachable LED lamp for 3 hours. A percentage of all retail sales will go to providing SOCCKETs to schools in the developing world.



SOCCKET

⁵**inhalation:** the taking in of air, smoke, gas, etc., into the lungs as you breathe

⁶**fumes:** smoke, gas, or something similar that smells or is dangerous to breathe in

VOCABULARY SKILL REVIEW

In Unit 3, you learned about prefixes that change a word's meaning and suffixes that change the part of speech. As you learn new words, find out whether you can apply these prefixes or suffixes to make related words.

B. VOCABULARY Here are some words and phrases from Reading 1. Read the sentences. Circle the answer that best matches the meaning of each bold word.

- Being connected to the power **grid** is a luxury. But we seldom think about the ___ until something disrupts it.
a. network b. plan c. power
- In our rapidly changing world, we depend on **innovative** solutions to the problems we face. We need ___ ideas and ways of doing things.
a. big b. new c. smart
- Providing technology to help people is the goal of most **developing** nations. These ___ societies, like wealthy societies, are trying to improve lives.
a. rich b. advanced c. poor
- This is the best technology in **existence** today. The technology is ____.
a. not available yet b. real and available c. no longer available
- Both daughters **resemble** their mother. They ___ her.
a. like b. look like c. differ from
- They didn't read the instructions. Rather, they still succeeded in using the device **intuitively**. They understood how to do it ____.
a. well b. quickly c. without help
- The ceiling fans **alleviated** our discomfort. Our problems were ____.
a. made less severe b. worsened c. unaffected
- They are **dedicated** to helping as many people as possible. They are ___ to achieving their goal because the work is important.
a. committed b. on their way c. unwilling
- We need a **replacement** for this policy, which is having a negative impact on the environment. We must provide ____.
a. a place with clean air b. a new reason c. something better
- Electricity can be **generated** by using wind. It can also be ___ by using the sun and water, for example.
a. produced b. consumed c. wasted
- Motion** is necessary for good health. The ___ keeps us fit.
a. ability to move b. need for movement c. process of moving

12. Much of the innovation in technology is the result of the efforts of an individual or small **enterprise**. Innovation seems to happen less often in a large ____.
- a. industry b. company c. government organization

iQ PRACTICE Go online for more practice with vocabulary.
Practice > Unit 4 > Activity 3

C. EXPLAIN Discuss the questions with a partner.

1. What is the purpose of the review?
2. What are the advantages of all five of these technologies?
3. Who are the targeted users of these technologies?
4. Which technology uses solar power?
5. Which technology utilizes heat to provide electricity?
6. How does the GravityLight power a light?



CRITICAL THINKING STRATEGY

Categorizing information

When you **categorize information**, you put it into groups by type. This can help you see the relationships between ideas more clearly. For example:

What the device produces or conserves		
Electricity	Heat	
VOTO	Window Socket	Berkeley-Darfur Stove
GravityLight	SOCKET	

iQ PRACTICE Go online to watch the Critical Thinking Skill Video and check your comprehension. *Practice > Unit 4 > Activity 4*

D. CATEGORIZE Reread the descriptions of each technology in Reading 1. Then use the information to complete the charts.

What the electricity is used for	
Recharging devices	Producing light

What the device replaces		
Non-portable chargers	Less efficient stoves	Kerosene lamps

E. CATEGORIZE Read the statements. Write *T* (true) or *F* (false) and the paragraph number where the answer is found. Then correct each false statement to make it true according to the review.

- ___ 1. Few people today live off the power grid. (paragraph ___)
- ___ 2. Providing energy sources can open up new opportunities in developing countries. (paragraph ___)
- ___ 3. The VOTO converts the energy of wood-fueled stoves into energy to power lights, etc. (paragraph ___)
- ___ 4. The Window Socket uses solar panels to store ten hours of electricity. (paragraph ___)
- ___ 5. The Berkeley-Darfur Stove reduces the amount of wood needed for fuel. (paragraph ___)
- ___ 6. The GravityLight, designed to replace kerosene-burning lights, is expensive to buy. (paragraph ___)
- ___ 7. It costs a lot to use the GravityLight. (paragraph ___)
- ___ 8. Uncharted Power's SOCKET is a solar energy light designed to replace kerosene lamps. (paragraph ___)

F. SYNTHESIZE Look back at your Quick Write on page 94. How would your life be without electricity? Add any new ideas or information you learned from the reading.

iQ PRACTICE Go online for additional reading and comprehension.

Practice > Unit 4 > Activity 5



WRITE WHAT YOU THINK

A. DISCUSS Discuss the questions in a group. Think about the Unit Question, “How can science improve lives?”

1. Which of the five technologies seems most practical? Least practical?
2. Which of the five technologies seems easiest to provide to people in areas that don’t have access to electricity?
3. How can access to energy open up opportunities to people in developing nations? Give specific examples.

B. SYNTHESIZE Choose one of the questions from Activity A and write a paragraph of 5–7 sentences in response. Look back at your Quick Write on page 94 as you think about what you learned.

READING SKILL Understanding comparisons and contrasts

Writers **compare and contrast** information in order to examine the similarities and differences between two or more things. Phrases that signal similarities include *all (of), both, each, similarly, like, and likewise*. Phrases such as *in comparison with, by comparison, in contrast, and differs from* show differences. Comparisons can also be made using comparative and superlative adjectives: *better/worse, more/less . . . than, the best/worst*. Look at this paragraph:

Five innovative technologies seek to improve lives in developing countries with quick, efficient energy sources. There are similarities and differences in how each of the five technologies provides energy. **All of** the technologies seek to provide safe sources of energy on a user-by-user basis. **Likewise**, each technology is designed to provide energy as cheaply as possible. The technologies **differ** in how they provide energy. Two use wood-burning stoves. The VOTO converts heat from existing wood-burning stoves into electricity to power various devices. **By comparison**, the Berkeley-Darfur Stove is a **better** wood-burning stove that is **more** efficient. The other three technologies seek to provide electricity in **less** harmful ways by harnessing existing clean energy sources. The Window Socket uses solar energy to provide electricity. **In contrast**, the GravityLight and the SOCKET are designed to generate power using motion.

When a reading doesn’t explicitly make comparisons, as is the case with Reading 1, it is up to the reader to understand and infer the similarities and differences using the information provided. You can use a simple T-chart to quickly identify and separate the information.

Application of technology

Utilizes charcoal-/wood-fueled stoves	Harnesses existing clean energy sources to create electricity
The VOTO converts heat from wood-fueled stoves into electricity. The Berkeley-Darfur Stove provides a better wood-fueled stove that creates energy more efficiently.	The Window Socket provides electricity using solar power. The GravityLight replaces kerosene-burning lights with an electricity-generated light using gravity. The SOCCKET replaces kerosene-burning lights with an electric one using an internal motion-powered device.

You can also divide the information further by adding categories or topic areas down the side of the chart. After you chart the information, you can easily examine the ideas for similarities and differences.

A. CATEGORIZE Reread paragraphs 3–9 of Reading 1. Underline the phrases that describe each technology. Then write the information in the chart.

Device	Materials	Manner	Source of energy
VOTO	Charcoal-/wood-burning stove + VOTO device		
Window Socket		Solar panels store energy to use with any device (simple charger)	
Berkeley-Darfur Stove			Fire/Heat
GravityLight			
SOCCKET			

B. DISCUSS Discuss your chart with a partner and add any points that you missed. What similarities and differences do you see in the points?

iQ PRACTICE Go online for more practice with understanding comparisons and contrasts. *Practice > Unit 4 > Activity 6*

READING 2

This Device Pulls Water Out of Desert Air

OBJECTIVE ▶

You are going to read a news article by reporter Emily Matchar for Smithsonian.com. The article takes a look at a device that helps people live in arid places. Use the article to gather information and ideas for your Unit Assignment.

PREVIEW THE READING

- A. PREVIEW** Look at the title and subtitle. Why would a device like this be useful? Read the last paragraph. What do you think “water-stressed regions” are? How much water “satisfies the basic needs of the individuals”?
- B. QUICK WRITE** The average person needs about 10 gallons (38 liters) of clean water a day for drinking and cleaning. Imagine you had only 2 gallons (7.5 liters). What would you have to give up or do differently? Write for 5–10 minutes in response. Remember to use this section for your Unit Assignment.
- C. VOCABULARY** Check (✓) the words you know. Use a dictionary to define any new or unknown words. Then discuss with a partner how the words will relate to the unit.

absorb (v.) **🔍+**

caution (v.) **🔍+**

drought (n.) **🔍+**

extract (v.) **🔍+**

framework (n.) **🔍+ OPAL**

implication (n.) **🔍+**

organic (adj.) **🔍+**

porous (adj.)

potentially (adv.) **🔍+ OPAL**

premise (n.) **🔍+**

shortage (n.) **🔍+**

yield (n.) **🔍+ OPAL**


🔍+ Oxford 5000™ words

OPAL Oxford Phrasal Academic Lexicon

iQ PRACTICE Go online to listen and practice your pronunciation.

[Practice](#) > [Unit 4](#) > [Activity 7](#)

WORK WITH THE READING

-  A. **INVESTIGATE** Read the article and gather information about a device that helps people live in arid places.

THIS DEVICE PULLS WATER OUT OF DESERT AIR



A new water harvester¹ can extract water from extremely dry air using only solar energy.

By Emily Matchar

- Droughts** have been making headlines across the world in recent years, from the California water crisis to Cape Town's severe water **shortage**. Research suggests 25 percent of the globe could eventually be left in permanent drought due to climate change. But what if you could simply pull water from the air?
- That's the **premise** of a new technology developed by University of California, Berkeley researchers. It's a water harvester that can **extract** water from the air, even in extremely dry climates. It uses no energy other than ambient² sunlight.
- The key to the water harvester is a new class of materials called **metal-organic frameworks** (MOFs). These MOFs are solid but **porous** materials with enormous surface areas. An MOF the size of a sugar cube can have the internal surface area as big as many football fields. This means that they can **absorb** gases and liquids, and then release them quickly when heat is added.
- "Certain MOFs have an extraordinary ability to suck in water vapor from the atmosphere, but then at the same time do not hold on to the water molecules inside their pores too tightly so that it is easy to get the water out," says Omar Yaghi. He is a professor of chemistry at Berkeley and led the research.
- The researchers tested the harvester in Scottsdale, Arizona. It is a desert town with a high of 40 percent humidity at night

¹ **water harvester**: a machine that gathers water

² **ambient**: relating to the surrounding area; on all sides

and 8 percent humidity during the day. The researchers believe that the harvester could ultimately extract about 3 ounces of water per pound of MOF per day.

6 The harvester itself is a box inside a box. The inner box contains a bed of MOFs. The outer box is a two-foot transparent³ plastic cube. At night, the researchers left the top off the outer box to let air flow past the MOFs. In the day, they put the top back on, so the box would be heated by the sun. The heat would pull the water out of the MOFs, where it would condense on the inner walls of the plastic cube before dripping to the bottom, where it could be collected.

7 “The most important aspect of this technology is that it is completely energy-passive,” says Eugene Kapustin, a Berkeley graduate student who worked on the research. That is to say, it needs no energy besides the sun. This makes it environmentally friendly and accessible⁴ to people in places with limited electricity. The results of the trials were published in the journal *Science Advances* (Fathieh, 2018).

8 The team needs to conduct more trials on the current models to figure out which factors most affect how much water can be harvested. They also hope to learn more about how specific climate conditions affect water **yield**. The next trial is planned for late summer in Death Valley, where the nighttime humidity can be as low as 25 percent.

9 Yaghi has also developed a new aluminum-based MOF. He says it is 150 times cheaper and can capture twice as much water as the current MOFs. He and his team are designing a new water harvester that actively pulls air into the MOFs at high speed. It thus delivers a much larger volume of water.

10 The team is now partnering with industry to test harvesters on an industrial scale. They also continue to search for newer, better, and cheaper MOFs. “I am very happy to see that more and

more researchers around the world are joining our efforts in this regard,” Yaghi says.

11 The idea of sucking water out of the atmosphere is not new, says Eric Hoek. He is an engineering professor at the University of California, Los Angeles and editor of the journal *npj Clean Water*. It’s long been noted that when you run an air conditioner, water drips out. This is because the machine is cooling the air to the dew point, the temperature at which the air is saturated with water vapor and condensation occurs.

12 But creating water harvesters based on cooling technology is incredibly energy intense. In very dry climates, the dew point is below zero. Cooling the air to that temperature at any large scale is unfeasible.

13 “The real innovation [of Yaghi’s research] is a materials innovation,” Hoek says. “These materials [the MOFs] pull water out and more easily give it up.” But the concept is challenging to scale⁵, Hoek **cautions**, as the amount of water produced per square inch of harvester is relatively low. Thus a large harvester would **potentially** take up a huge amount of land. “But maybe for a household or village, it could be a very interesting way for someone to get fresh water,” Hoek says.

14 Yaghi imagines exactly that: a future where everyone without easy access to fresh water has a harvester in their yard.

15 “My vision is to achieve ‘personalized water,’ where people in water-stressed regions have a device at home running on ambient solar, delivering the water that satisfies the basic needs of the individuals,” he says. “More than one third of the population in the world lives in water-stressed regions or is suffering from a lack of clean water. The potential **implications** of this technology in transforming people’s lives and improving the global public health conditions are tremendous.”

Reference Fathieh, Farhad et al. (2018). Practical Water Production from Air. *Science Advances*, 4 (6)

³**transparent:** something that can be seen through

⁴**accessible:** something that can be reached, entered, used, seen, etc.

⁵**scale:** to change the size of something

B. VOCABULARY Here are some words from Reading 2. Read the sentences. Then write each bold word next to the correct definition. You may need to change verbs to their base form and nouns to the singular form.

1. The **premise** that drives their research is the idea that many people need access to clean water.
 2. The **implication** of the research is that, with this technology, it is possible to ensure an adequate supply of water.
 3. The device uses a simple **framework** of two boxes, one inside the other.
 4. **Organic** materials always contain some carbon since carbon is a basic element of living things.
 5. Long **droughts** often lead to wildfires because plants dry up and burn easily.
 6. If we have a **shortage** of water, we may need to give up taking long showers.
 7. The purpose of a paper towel is to **absorb** water or other liquids.
 8. We put sand in the soil to make the soil more **porous**, letting water move through it more easily.
 9. The professor **cautioned** us to not spend too much time on our project.
 10. We wanted to **extract** the salt from the sea water so that we could drink the water.
 11. There are **potentially** many uses for this device; the possibilities are many.
 12. Farmers need to estimate the **yield** for each field, so they can estimate how much money they will make.
- a. _____ (n.) a possible effect or result of an action or a decision
 - b. _____ (n.) the parts of an object that support its weight and give it shape
 - c. _____ (n.) a statement or an idea that forms the basis of an argument
 - d. _____ (v.) to take in a liquid, gas, or other substance from the surface or space around
 - e. _____ (n.) a situation when there is not enough of the people or things that are needed
 - f. _____ (adj.) having many small holes that allow water or air to pass through slowly
 - g. _____ (v.) to remove or obtain a substance from something

- h. _____ (*n.*) a long period of time when there is little or no rain
- i. _____ (*v.*) to warn somebody about the possible dangers or problems of something
- j. _____ (*n.*) the total amount of crops, profits, etc., that are produced
- k. _____ (*adv.*) used to say that something may happen; possibly
- l. _____ (*adj*) produced by or from living things

iQ PRACTICE Go online for more practice with the vocabulary.
Practice > Unit 4 > Activity 8

C. IDENTIFY Circle the correct answer. Then write the paragraph number where the answer is found.

1. What are MOFs (metal-organic frameworks)? (paragraph ____)
 - a. solid materials that are small but have a lot of surface area
 - b. materials that take in liquids and gases
 - c. materials that release liquids and gases when they are heated
 - d. all of the above
2. A water harvester is a box inside a box. What is the purpose of the outside box? (paragraph ____)
 - a. It protects the inside box from animals.
 - b. It collects the water that evaporates.
 - c. It makes the water harvester easier to see.
 - d. It focuses the sunlight on the box.
3. Why is the lid taken off the water harvester at night? (paragraph ____)
 - a. to make it easier to inspect
 - b. to allow the MOFs to absorb water
 - c. to dry the MOFs
 - d. to let insects drink the water from the box

4. Why is the lid put on the water harvester during the day? (paragraph ____)
 a. so that the MOF can absorb sunlight
 b. so that it can reflect the heat away from the box
 c. so that the box will trap the water released by the MOF
 d. so that dirt and animals don't get into the box
5. What is the main problem with water harvesters? (paragraph ____)
 a. They don't yield much water for their size.
 b. They use a lot of energy.
 c. They are hard to maintain.
 d. They weigh too much.

D. RESTATE Write the meaning of these phrases from the article.

1. energy-passive (paragraph 7) _____
2. conduct more trials (paragraph 8) _____
3. nighttime humidity (paragraph 8) _____
4. sucking water out of the atmosphere (paragraph 11)

5. dew point (paragraphs 11 and 12) _____
6. "personalized water" (paragraph 15) _____

E. EXPLAIN Discuss the questions with a partner.

1. What is the major benefit of the water harvesters?
2. Why do the scientists test the water harvesters in deserts?
3. What are two benefits of the water harvesters being "energy-passive"?
4. Why would Omar Yaghi "test harvesters on an industrial scale" (paragraph 10)?
5. Why don't scientists cool the air to get the water out of it?
6. Reread the last sentence in the article. How could a water harvester transform someone's life?



WORK WITH THE VIDEO



A. PREVIEW Can we do something about global warming? If so, what?

VIDEO VOCABULARY

reflective (adj.) sending back heat or light

enhance (v.) to increase or further improve the good quality of something

particle (n.) a very small piece of something

vapor (n.) a mass of very small drops of liquid in the air

replicating (n.) producing exact copies of



iQ RESOURCES Go online to watch the video about geoengineering inventions used to save the planet by combatting global warming.
Resources > Video > Unit 4 > Unit Video

B. COMPOSE Watch the video two or three times. Take notes in the chart.

	Putting tiny reflective lenses into space	Making clouds thicker and more reflective	Releasing sulfur into the stratosphere
Notes from the video			
My ideas			

C. EXTEND What are the advantages and disadvantages of each invention? Which idea seems the most likely to work? Write your ideas in the chart above. Discuss your ideas with a partner.

WRITE WHAT YOU THINK

SYNTHESIZE Think about Reading 1, Reading 2, and the unit video as you discuss these questions. Then choose one question and write a paragraph of 5–7 sentences in response.

1. Some inventions start out being for one group of people but end up being useful for other groups of people as well, such as the VOTO in Reading 1. Which of the technologies in the readings and the video could you use?
2. Many technologies have both positive and negative aspects. Choose a technology that you use (cell phone, automobile, etc.). What are the positive and negative points of that technology?
3. A popular expression in English is, “Necessity is the mother of invention.” Think of a need you know of in any country, in any field. What technology, existing or imagined, would address that need?

VOCABULARY SKILL Using the dictionary to distinguish between homonyms

Finding the correct meaning

There are many words that have the same spelling and pronunciation but different meanings. These words are called *homonyms*.

lift (*v.*) to raise something to a higher position

I **lifted** the lid of the box and peered in.

lift (*v.*) to copy ideas or words without asking permission

She **lifted** most of the ideas from a book she had been reading.

lift (*v.*) to become or make more cheerful

His heart **lifted** at the sight of a house in the distance.

field (*n.*) (usually in compounds) an area of land used for the purpose mentioned

Her excitement grew as she kicked the ball down the soccer **field**.

field (*n.*) a particular subject or activity that somebody works in or is interested in

He is an expert in the **field** of chemistry.

Some homonyms may have different parts of speech, for example, a noun form and a verb form.

scale (*n.*) the size of something


The team is now testing harvesters on an industrial **scale**.

scale (*v.*) to change the size of something

The concept is challenging to **scale**.

Advanced dictionaries will list all the word forms and definitions for them. When using a dictionary to find the correct meaning of a word, it is important to read the entire sentence where you found the word and consider the use and context.

A. IDENTIFY Look at the dictionary entry for *range*. Check (✓) the correct answers.

range  /reɪndʒ/ noun, verb

• **noun**

- **VARIETY 1** [C, usually sing.] ~ (of sth) a variety of things of a particular type: *The hotel offers a wide range of facilities.*
 - ◆ *There is a full range of activities for kids.*
- **LIMITS 2** [C, usually sing.] the limits between which something varies: *Most of the students are in the 17–20 age range.*
 - ◆ *There will be an increase in the range of 0 to 3 percent.* ◆ *It's difficult to find a house in our price range (= that we can afford).*
 - ◆ *This was outside the range of his experience.*
- **DISTANCE 3** [C, U] the distance over which something can be seen or heard: *The child was now out of her range of vision (= not near enough for her to see).* **4** [C, U] the distance over which a gun or other weapon can hit things: *These missiles have a range of 300 miles.* **5** [C] the distance that a vehicle will travel before it needs more fuel
- **MUSIC 6** [C, usually sing.] all of the notes that a person's voice or a musical instrument can produce, from high to low: *She was gifted with an incredible vocal range.*
- **ABILITY 7** [C, usually sing.] the full extent of a person's knowledge or abilities: *Those two movies give some indication of his range as an actor.*
- **OF MOUNTAINS 8** [C] a line or group of mountains or hills: *the great mountain range of the Alps*
- **FOR SHOOTING 9** [C] an area of land where people can practice shooting or where bombs, etc. can be tested: *a shooting range*
- **OF PRODUCTS 10** [C] a set of products of a particular type

SYN LINE: *our new range of hair products*

• **verb**

- **VARY 1** [I] to vary between two particular amounts, sizes, etc., including others between them: ~ **from A to B to range in size/length/price from A to B** ◆ *Accommodations range from tourist class to luxury hotels.* ◆ ~ **between A and B** *Estimates of the damage range between \$1 million and \$5 million.* **2** [I] to include a variety of different things in addition to those mentioned: ~ **from A to B** *She has had a number of different jobs, ranging from chef to swimming instructor.* ◆ + **adv./prep.** *The conversation ranged widely (= covered a lot of different topics).*
- **ARRANGE 3** [T, usually passive] ~ **sb/sth/yourself + adv./prep. (formal)** to arrange people or things in a particular position or order: *The delegates ranged themselves around the table.* ◆ *Spectators were ranged along the whole route of the procession.*
- **MOVE AROUND 4** [I, T] to move around an area: + **adv./prep.** *He ranges far and wide in search of inspiration for his paintings.* ◆ ~ **sth** *Her eyes ranged the room.*

All dictionary entries adapted from the *Oxford American Dictionary for learners of English* © Oxford University Press 2011.

1. *Range* can be used as:

- | | |
|---------------------------------|---------------------------------------|
| <input type="checkbox"/> a noun | <input type="checkbox"/> an adjective |
| <input type="checkbox"/> a verb | <input type="checkbox"/> an adverb |

2. *Range* can mean:

- | | |
|---|---|
| <input type="checkbox"/> to vary | <input type="checkbox"/> light |
| <input type="checkbox"/> distance over which something can be heard or seen | <input type="checkbox"/> to move around |
| <input type="checkbox"/> to lift | <input type="checkbox"/> music |

B. IDENTIFY Read the excerpts from Readings 1 and 2. Look up each bold word in your dictionary. Write the part of speech and the correct definition based on the context.

Reading 1

1. The devices do not need the years it takes to extend the **power** grid to remote places.

2. That electricity can power a handheld light, **charge** a phone, or even charge a spare battery.

3. Just **stick** it on a sunny window for 5–8 hours, with the built-in suction cup.

4. The solar panels on the back will **store** about ten hours' worth of electricity that can be used with any device.

5. With that in mind, engineers and designers have recently created a range of innovative devices that can increase the supply of **safe**, cheap energy on a user-by-user basis.

Reading 2

6. In the day, they put the top back on, so the box would be **heated** by the sun.

7. The heat would pull the water out of the MOFs, where it would **condense** on the inner walls of the plastic cube before dripping to the bottom, where it could be collected.

8. Cooling the air to that temperature at any large **scale** is unfeasible.

iQ PRACTICE Go online for more practice with using the dictionary to distinguish between homonyms. *Practice > Unit 4 > Activity 9*

WRITING

OBJECTIVE ►

At the end of this unit, you will write an essay comparing and contrasting two new technologies that can improve lives. This essay will include specific information from the readings, the unit video, and your own ideas.

WRITING SKILL Writing a compare and contrast essay

A **compare and contrast essay** describes the similarities and differences between two subjects. Comparisons show their similarities, while contrasts examine their differences.

Introduction

The introduction describes the two subjects being compared and contrasted. It has a thesis statement that explains the relationship between the two subjects or gives reasons why the relationship is important.

Body paragraphs

There are many different ways to organize the body paragraphs of a compare and contrast essay. Before you write a compare and contrast essay, it is important to decide which organization is best for your essay. Here are two ways to organize your ideas:

- In a **point by point essay**, you choose three or more key points to compare and contrast. Each body paragraph compares and contrasts one key point. This organization can be best when you want to balance your essay evenly between your two subjects.
- In a **similarities and differences essay**, the first body paragraph explains what is similar about the two subjects. The second body paragraph explains what is different about the two subjects. The third body paragraph discusses the most important similarities and differences. This organization can be best when you want to explain why one subject is better than the other subject, or what is significant about their similarities or differences.

Conclusion

The conclusion summarizes the similarities and differences and gives the writer's opinion about the topic. It can explain why one of the subjects is better than the other or why they are of equal value.

iQ RESOURCES Go online to watch the Writing Skill Video.

[Resources](#) > [Video](#) > [Unit 4](#) > [Writing Skill Video](#)

A. WRITING MODEL Read the model compare and contrast essay.
Then answer the questions that follow.



Otto Lilienthal



The Wright brothers

The Dream of Flight

- 1 Flying has long been a dream of many people. Two sets of brothers are universally acknowledged to have contributed immensely to heavier-than-air flight. These brothers, the Lilienthals of Germany and the Wrights of the United States, share some similarities but also have some differences.
- 2 The Lilienthals, Otto and Gustav, worked together, as did the Wrights, Orville and Wilbur. Unlike the Wright brothers, who are usually spoken of together, the Lilienthal brothers weren't equally famous. Otto is usually spoken of individually. Otto opened a business that made boilers and steam engines, which made enough money for him to pursue his hobby of flight. When engaging with aircraft, Otto always worked with Gustav. The Wright brothers opened a printing business and then a bicycle shop. They developed their innovations to the airplane together as well. They shared credit for their inventions and depended on their businesses, including their work in aviation, to make a living.
- 3 While Otto Lilienthal was educated and employed as an engineer, the Wright brothers did not study at a university. The Wright brothers were mostly self-taught. In fact, one of the books that the Wrights were inspired by was authored by Otto Lilienthal.
- 4 Both Otto Lilienthal and the Wright brothers were inventors; many of their patents were related to aircraft. Otto and the Wright brothers were interested in gliders, specifically in how to control them. Both Otto Lilienthal and the Wrights studied birds in order to ascertain how birds were able to control themselves in flight. Otto, who made over 2,000 flights in gliders, was known as "the father of flight" because he was the first to sustain a controlled flight in a heavier-than-air aircraft, a glider. The Wrights are credited with the three-axis control (up and down, side to side, and forward and backward) for aircraft, which is still used in fixed-wing aircraft today. They are also credited with achieving the first sustained, controlled flight of an airplane. The Lilienthals and the Wrights were both influential in developing heavier-than-air aircraft, especially contributing to the control of the aircraft. Otto Lilienthal held patents on his inventions. Similarly, the Wright brothers held patents on their inventions and went on to build airplanes.
- 5 Despite their differences, the Lilienthals and the Wright brothers will always be remembered for their contributions to helping people achieve the dream of flight.

1. What is the thesis statement? Underline it.
2. How is the essay organized? _____
3. Why do you think the author organized it this way?

B. CATEGORIZE Reread the essay on page 113. Complete the chart with both the similarities and the differences for each key point. Then compare with a partner.

Compare and contrast essay: Point by point		
Key points	The Lilienthal brothers	The Wright brothers
1. supporting businesses		
2. education		
3. inventions/interest in flight		

C. CATEGORIZE Work with a partner. Complete the chart below. Reorganize the information from the essay into a plan for a similarities and differences essay. Use the chart in Activity B to help you.

Compare and contrast essay: Similarities and differences		
Similarities	Differences	
	The Lilienthal brothers	The Wright brothers

D. CATEGORIZE Use the chart to help you think of examples of technology 100 years ago and technology now.

Compare and contrast essay: Similarities and differences		
Similarities	Differences	
	Technology 100 years ago	Technology now

- E. WRITING MODEL** Read the model compare and contrast essay. Then answer the questions that follow.



Two Chemicals That Have Changed Lives

- 1 How has chemistry improved your life? When not one chemist made the top 50 scientists in *Science* magazine in 2014, the Royal Academy of Chemistry decided to try to understand why. It seems that when we think of innovations, chemistry is often overlooked. But, in fact, chemistry has led to many improvements in our lives. Two other important innovations in chemistry, penicillin and ammonia, have contributed to the world as we know it today, though each has done so in different ways.
- 2 Both penicillin and ammonia are naturally occurring on earth. Penicillin is a mold, and ammonia is a chemical compound. They were also both discovered around the same time. Penicillin was discovered in 1928, by Scottish bacteriologist Alexander Fleming. Just more than a decade later, Australian pharmacologist Howard Florey purified penicillin into useable amounts, and in 1944, chemical engineer Margaret Hutchinson Rousseau was able to put it into production. Similarly, in 1910, German chemists Fritz Haber and Carl Bosch were working on the formulation that would become ammonia. They did it by combining nitrogen and hydrogen. This process of making ammonia, called the *Haber-Bosch process*, allowed for the greater access to nitrogen of both plants and animals. Both penicillin and ammonia have been used to improve our lives.
- 3 While penicillin and ammonia share similarities, there are differences. The main difference is in how they are used. Penicillin is an important medical treatment used to cure many bacterial diseases. It has saved the lives of millions of people since it was first put into full-scale production in 1944. Ammonia, on the other hand, has been used mostly as a fertilizer, resulting in increased food production, cited as the most important factor in the population explosion over the last century.
- 4 However, the most significant similarity between these two innovations is how they are used and perceived today. With both, there is caution in their use. The reasons for that caution are very similar. Penicillin's use (or some would argue, overuse) has resulted in bacteria that are increasingly resistant to penicillin. Therefore, doctors are much more careful now in prescribing it to their patients. Similarly, ammonia is now understood to be a toxic chemical compound that is irritating and caustic. This has resulted in efforts to find alternatives to using it.
- 5 In conclusion, no one would dispute that these two chemistry inventions, penicillin and ammonia, have improved our lives since their discovery and development in the early twentieth century. But they have also shown us that even a good thing must be used carefully. Chemists must continue to conduct research on the chemicals that we use to improve lives.

1. What is the thesis statement? Underline it.
2. How is the essay organized?

3. Why do you think the author organized it this way?

F. CATEGORIZE Create a chart for the essay “Two Chemicals That Have Changed Lives” like the ones in Activities C and D.

iQ PRACTICE Go online for more practice writing a compare and contrast essay. [Practice > Unit 4 > Activity 10](#)

GRAMMAR Subordinators and transitions to compare and contrast

You can use different words and phrases to **compare and contrast** ideas.

Subordinators showing contrast

You can use an adverb clause to show an idea that contrasts with the main clause. The subordinators *although* and *though* show contrasting ideas. *Whereas* and *while* often signal more direct opposition. Notice the comma when the adverb clause comes first.

main clause subordinator

In wealthy nations, electricity is distributed through a power grid whereas in developing countries, electricity is less common and people depend on burning wood or kerosene for heat and light.

subordinator adverb clause

Although extending the power grid to remote areas is possible, it takes years and can be expensive.

main clause

subordinator adverb clause

Though the innovative devices can only provide energy on a user-by-user basis, they can supply safe, cheap energy more quickly.

main clause

Transitions showing comparison

You can use some transition words to show comparison. Some common transition words to introduce comparison are *similarly*, *likewise*, and *in addition*. These are used to discuss similarities.

The GravityLight is a replacement for kerosene lamps. **Similarly**, the SOCKET replaces kerosene lamps with an electric light.

All of the innovative devices provide energy on a user-by-user basis. **In addition**, they use sources that are readily available.

Providing new energy sources would open up new opportunities for people in developing countries. **Likewise**, it opens up opportunities for engineers and designers.

Transitions showing contrast

You can use other transition words to show contrast or differences.

Contrast	More direct opposition	Concession
however though	on the other hand in contrast	nevertheless in spite of this nonetheless despite this

Both the GravityLight and the SOCKET replace kerosene lamps. **However**, they use different methods to generate electricity.

The GravityLight uses the energy generated by a falling motion to create electricity for the light. **On the other hand**, the SOCKET uses an internal motion-powered device to generate and store electricity.

ACADEMIC LANGUAGE

The corpus shows that *in contrast* and *in contrast to* are often used in academic writing.

... *In contrast,*
ammonia is . . .

... *In contrast to*
penicillin, ammonia is . . .

A. IDENTIFY Read each sentence. Underline the word or phrase that indicates a comparison or a contrast. Then write CP (comparison) or CT (contrast).

- ___ 1. The GravityLight and the SOCKET each uses motion to generate energy, though they use different types of motion.
- ___ 2. The Berkeley-Darfur Stove helps users directly, improving health by reducing the amount of smoke inhaled. Similarly, it helps users by shortening the amount time spent gathering wood to fuel the stove.
- ___ 3. Each of the innovative technologies described in the review provides energy simply and safely. Nonetheless, some of them are more effective than others.
- ___ 4. While the Window Socket uses solar energy to generate power, VOTO uses the heat produced by a charcoal- or wood-burning stove.
- ___ 5. The electricity produced by VOTO can power a phone. Likewise, VOTO can even charge a spare battery.

B. IDENTIFY Circle the best phrase to complete each sentence.

1. The Wright brothers shared fame equally whereas *Otto Lilienthal was more famous than his brother, Gustav* / *the Lilienthal brothers were also equally famous.*
2. The Wright brothers had patents. Likewise, Otto Lilienthal *never had patents* / *had patents.*
3. Although the Wright brothers were self-educated, Otto Lilienthal *was also self-educated* / *was an engineer.*
4. The Wright brothers were self-educated. Despite this, they *built airplanes* / *didn't build airplanes.*
5. Otto Lilienthal is credited with the first heavier-than-air flight in a glider. In contrast, the Wright brothers *also are credited with heavier-than-air flight in a glider* / *are credited with heavier-than-air flight in an airplane.*

C. APPLY Complete the sentences using your own ideas. Make sure you use correct punctuation.

1. I think that science can improve lives. Nevertheless _____
_____.
2. Although penicillin has saved many lives _____
_____.
3. Water is essential to all living things. Similarly _____
_____.
4. I think I could live without a television. On the other hand _____
_____.
5. Technology has benefitted us in many ways. However _____
_____.
6. Whereas many people in the world get electricity from a power grid _____
_____.

iQ PRACTICE Go online for more practice with subordinators and transitions to compare and contrast. *Practice > Unit 4 > Activities 11–12*

UNIT ASSIGNMENT Write a compare and contrast essay

OBJECTIVE ►

In this assignment, you are going to write a five-paragraph essay comparing and contrasting two innovative technologies that can improve lives. As you prepare your essay, think about the Unit Question, “How can science improve lives?” Use information from Reading 1, Reading 2, the unit video, and your work in this unit to support your essay. Refer to the Self-Assessment checklist on page 120.

iQ PRACTICE Go online to the Writing Tutor to read a model compare and contrast paragraph. *Practice* ► *Unit 4* ► *Activity 13*

PLAN AND WRITE

WRITING TIP

When you brainstorm ideas using both a point by point and a similarities and differences chart, it will help you discover which organization works best for your subject, and you may get more ideas.

A. BRAINSTORM Follow these steps to help you organize your ideas.

1. Complete the chart. List new technologies that scientists have discovered, invented, or designed to improve lives in the fields indicated. Add another field and technologies you are familiar with. Compare charts with a partner.

Field	Technologies
Chemistry	
Physics	
Engineering	
Education	

2. Choose the two technologies you would like to use as your subject to compare and contrast.
3. Write points to compare and contrast and similarities and differences for your subject. (Refer to the charts on p. 114 to help you organize your ideas.)

B. PLAN Plan your essay.

Look at your ideas from question 3 in Activity A. Decide whether your essay would be best organized as a point by point essay or a similarities and differences essay.

iQ RESOURCES Go online to download and complete the outline for your compare and contrast essay. *Resources* ► *Writing Tools* ► *Unit 4* ► *Outline*

C. WRITE Use your planning notes to write your essay.

1. Write your essay comparing and contrasting two innovative technologies to improve lives. Be sure to include an introduction with a thesis statement, three body paragraphs, and a conclusion.
2. Look at the Self-Assessment checklist on page 120 to guide your writing.

iQ PRACTICE Go online to the Writing Tutor to write your assignment.
Practice > Unit 4 > Activity 14

REVISE AND EDIT

iQ RESOURCES Go online to download the peer review worksheet.
Resources > Writing Tools > Unit 4 > Peer Review Worksheet

- A. PEER REVIEW** Read your partner's essay. Then use the peer review worksheet. Discuss the review with your partner.
- B. REWRITE** Based on your partner's review, revise and rewrite your essay.
- C. EDIT** Complete the Self-Assessment checklist as you prepare to write the final draft of your essay. Be prepared to hand in your work or discuss it in class.

SELF-ASSESSMENT	Yes	No
Does the thesis statement explain the relationship between the two subjects or give reasons why the relationship is important?	<input type="checkbox"/>	<input type="checkbox"/>
Is the essay organized using one of the compare and contrast essay types?	<input type="checkbox"/>	<input type="checkbox"/>
Does the essay contain an introduction, three body paragraphs, and a conclusion?	<input type="checkbox"/>	<input type="checkbox"/>
Does the essay use subordinators and transitions to compare and contrast?	<input type="checkbox"/>	<input type="checkbox"/>
Does the essay include vocabulary from the unit?	<input type="checkbox"/>	<input type="checkbox"/>
Did you check the essay for punctuation, spelling, and grammar?	<input type="checkbox"/>	<input type="checkbox"/>

- D. REFLECT** Discuss these questions with a partner or group.
1. What is something new you learned in this unit?
 2. Look back at the Unit Question—How can science improve lives? Is your answer different now than when you started the unit? If yes, how is it different? Why?

iQ PRACTICE Go to the online discussion board to discuss the questions.
Practice > Unit 4 > Activity 15



TRACK YOUR SUCCESS

iQ PRACTICE Go online to check the words and phrases you have learned in this unit. *Practice > Unit 4 > Activity 16*

Check (✓) the skills and strategies you learned. If you need more work on a skill, refer to the page(s) in parentheses.

CRITICAL THINKING

I can categorize information. (p. 98)

READING

I can understand comparisons and contrasts. (p. 100)

VOCABULARY

I can use the dictionary to distinguish between homonyms. (p. 109)

WRITING

I can write a compare and contrast essay. (p. 112)

GRAMMAR

I can use subordinators and transitions to compare and contrast. (p. 116)

OBJECTIVE ▶

I can gather information and ideas to write an essay comparing and contrasting two new technologies that can improve lives.