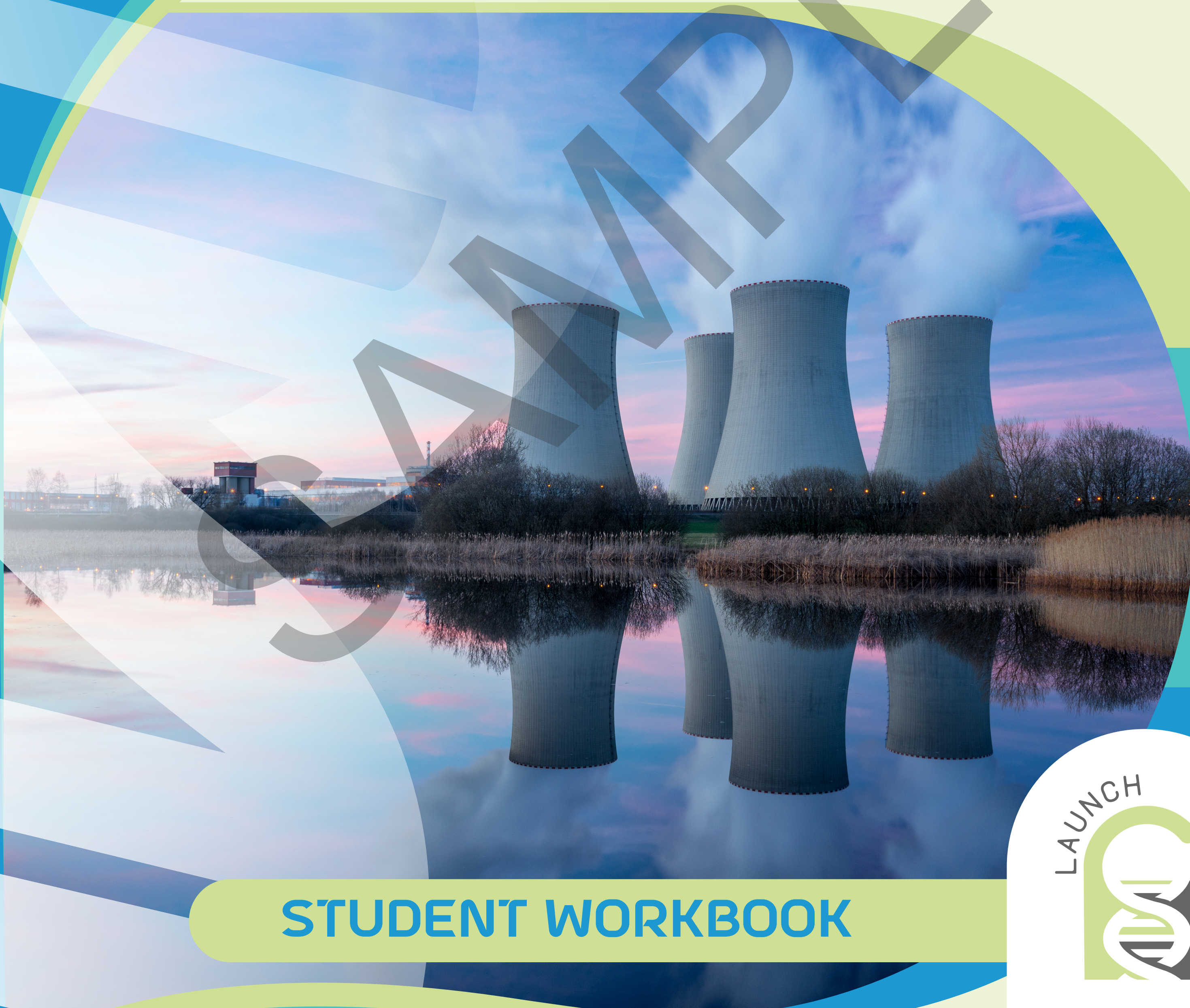
NATURALLY NUCLEAR



STUDENT WORKBOOK

ACTIVITY 1

ENVIRONMENTAL ENERGY

Where does nuclear energy come from? How powerful are nuclear reactions? In this activity, you will learn about a nuclear reactor that's a bit unusual. Before you do, you will reflect on your current knowledge about nuclear reactions.

1 NUCLEAR KNOWLEDGE

Throughout the following activities, you will explore several aspects of nuclear reactions.

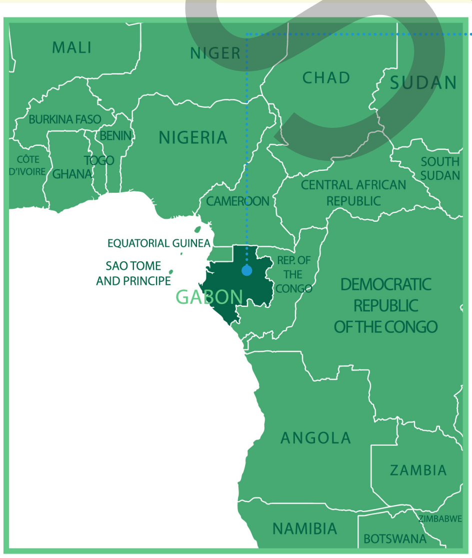
- First, you will organize your thoughts using the KWLQA graphic organizer on page 4.
- For now, you will complete only the K and W parts of the chart. You will come back to it several times throughout the kit.
- In the K section, write what you already know about nuclear reactions.
- In the W section, write at least two things you want to know about nuclear reactions.

2 RADIOACTIVE ROCKS

REFLECT

One thing not represented by the KWLQA you just started is how you *feel* about nuclear energy.

What thoughts, opinions, and feelings do you have about the use of nuclear reactions in society, industry, and science?



The Oklo Mine is a uranium mine in Gabon, a country on the west coast of Central Africa.

While there are many uranium mines throughout the world that supply the materials for human-made nuclear reactors, the Oklo Mine is the only mine with a history of acting as a natural nuclear reactor in the past.

Image courtesy of Department of Energy

Image courtesy of DOE

Image courtesy of International Atomic Energy Agency

ACTIVITY 2

HARNESS THE POWER

While natural nuclear reactors are rare, those made by people are more common than you might expect. What are these artificial reactors like? How and why do people use them?

LEARNING GOALS:

- I can make a model to show that total bond energy affects the release or absorption of energy in a chemical reaction.
- I can develop models of changes in the nucleus of an atom and the energy released during fission, fusion, and radioactive decay.

ENERGY IS ESSENTIAL

3

Energy From Chemical Reactions

What do you think was the first way that humans were able to harness the energy of natural materials? Fire is likely what came to mind. Fire is the energy released by a **combustion reaction**, a chemical reaction in which a fuel reacts with oxygen gas, releasing thermal energy.

Most often, the fuel in a combustion reaction is a hydrocarbon, a molecule with a chain of carbon atoms attached to hydrogen atoms.

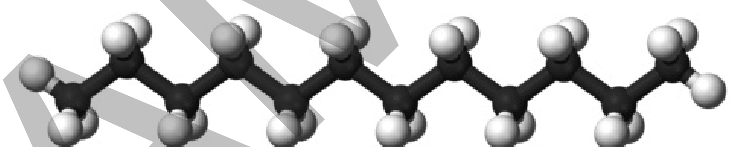


Image courtesy of National Aeronautics and Spacedministration

Dodecane is a straight-chain hydrocarbon used in jet fuel.

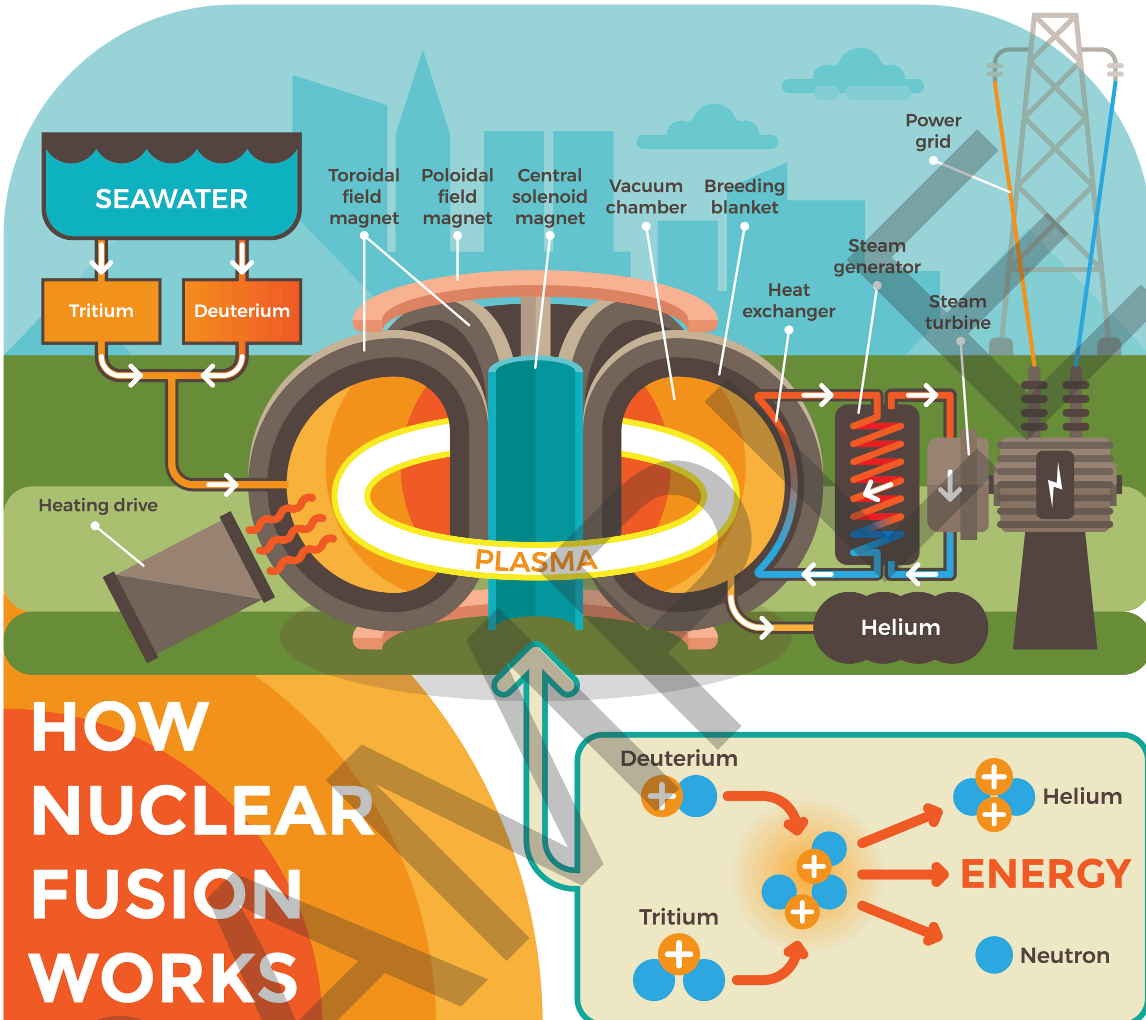
Humans have used fiery combustion to release thermal energy from the hydrocarbons found in plants for thousands of years. As civilization grew, people needed more and more energy to perform the activities of daily life. The energy released by wood-burning fire was not enough to power things like steam engines, factories, homes, and cars.

During the Industrial Revolution in the 19th century, people began to burn coal on a large scale. Burning coal releases more thermal energy for the same mass of material compared to wood. Eventually, people began to use fuels that were even more efficient, such as kerosene, propane, natural gas, and hydrogen.

Coal is shoveled into a steam engine to make it move

A Fusion Future

Nuclear fission is widely used worldwide, but there is another type of nuclear reaction that releases even more energy: nuclear fusion. **Nuclear fusion** is a nuclear reaction in which two smaller atomic nuclei merge to form a single, heavier nucleus. Fission is breaking nuclei apart, while fusion is joining them together.



Nuclear fusion is contained in a tokamak, a donut-shaped nuclear reactor with powerful magnets.

Nuclear fusion happens constantly in stars, including the Sun. The immense heat and bright light of stars are evidence of the tremendous amount of energy released by this process.

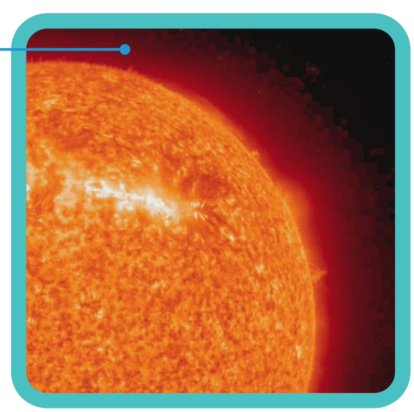


Image courtesy of NASA

Nuclear fusion is still in its early stages on Earth, but several teams of scientists and engineers are working on ways to use it to generate electricity. In February 2022, a team from JET Laboratory in the United Kingdom hit an important milestone: they sustained nuclear fusion for five seconds, producing 59 MJ of energy, enough to power 35,000 homes for those five seconds.[2]

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