

Nuclear Energy Web Quest

Objectives:

- Describe the process used to obtain energy from radioactive elements
- Analyze the pros and cons of using nuclear energy

Task 1: Use the sites provided in order to describe the process of nuclear fission and fusion by answering the questions below.

Nuclear power

1. What is a fissile isotope and why is it important to fission?

Fissile materials are used as fuel in nuclear reactors as they have the ability to be split by neutrons in a self-sustaining nuclear chain reaction.

2. what element/isotope is used in nuclear power plants?

Nuclear power plants use a certain kind of uranium, referred to as U-235, for fuel because its atoms are easily split apart

3. What is a chain reaction?

the self-sustaining fission reaction spread by neutrons which occurs in nuclear reactors and bombs.

4. Label and use the diagrams below to explain fission and fusion

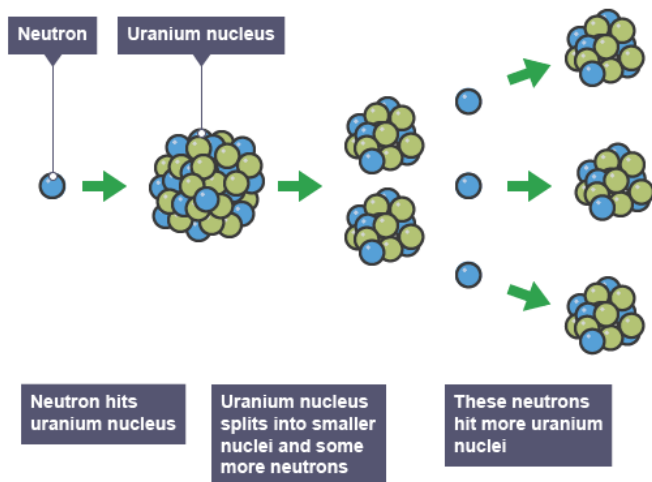
<https://www.bbc.co.uk/bitesize/guides/zgrr82/revision/3>

Fission

Fission is a process in which a nucleus with a large mass number splits into two nuclei, which have smaller mass numbers.

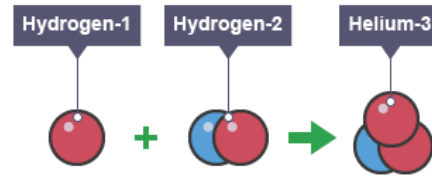
You need to know:

- Neutrons are usually released when fission takes place.
- Fission of a nucleus may be spontaneous, that is, it may happen at random due to internal processes within the nucleus.
- Fission can also be induced by bombarding a nucleus with a neutron. Induced fission is used to generate nuclear power and for weapons.
- The products formed during fission gain kinetic energy. It is this energy that is harnessed in nuclear power stations.



Fusion

Fusion is a process in which two nuclei combine to form a nucleus of larger mass number.



Nuclei collide and fuse together

- Fusion is the main nuclear process that occurs in the Sun and other stars.
- The products of fusion reactions also gain kinetic energy that can be harnessed.

Albert Einstein in his famous equation $E = mc^2$ showed that mass and energy are equivalent.

In this equation:

- E is energy in joules
- m is mass in kilograms
- c is the speed of light $3 \times 10^8 \text{ms}^{-1}$

Go to: <http://www.howstuffworks.com/nuclear-power.htm>

1. What is induced fission?

The reaction of neutron-induced fission occurs when a neutron interacts with a fissile or fissionable nucleus and the nucleus becomes unstable

2. How does a nuclear power plant work?

Complete the diagram and use it to explain. (see appendix)

4. What precautions are taken on the outside of a nuclear power plant?

A concrete liner typically houses the reactor's pressure vessel and acts as a radiation shield. That liner, in turn, is housed within a much larger steel containment vessel. This vessel contains the reactor core, as well as the equipment plant workers use to refuel and maintain the reactor. The steel containment vessel serves as a barrier to prevent leakage of any radioactive gases or fluids from the plant

An outer concrete building serves as the final layer, protecting the steel containment vessel. This concrete structure is designed to be strong enough to survive the kind of massive damage that might result from earthquakes or a crashing jet airliner

Go to: http://fusioned.gat.com/what_is_fusion.html

1. What is fusion?

Fusion is the process that powers the sun and the stars. It is the reaction in which two atoms of hydrogen combine together, or fuse, to form an atom of helium. In the process some of the mass of the hydrogen is converted into energy.

2. What is necessary in order to make fusion happen?

the atoms of hydrogen must be heated to very high temperatures (100 million degrees) so they are ionized (forming a plasma) and have sufficient energy to fuse, and then be held together i.e. confined, long enough for fusion to occur.

3. Why is fusion preferred over fission?

we will have an energy source that is inexhaustible

fusion would be environmentally friendly, producing no combustion products or greenhouse gases

the products of the fusion reaction (helium and a neutron) are not radioactive, and with proper design a fusion power plant would be passively safe, and would produce no long-lived radioactive waste. Design studies show that electricity from fusion should be about the same cost as present day sources.

Task 2: Use the sites below to investigate repercussions and disasters related to radiation.

Repercussions and disasters

Go to: <http://science.howstuffworks.com/nuclear-power5.htm>

1. What was the prime-worst nuclear disaster?

Chernobyl disaster

2. What happened at Chernobyl?

In 1986, the Ukrainian nuclear reactor exploded, spewing 50 tons (45 metric tons) of radioactive material into the surrounding area, contaminating millions of acres of forest. The disaster forced relocation of 150,000 people, and eventually caused thousands to die from cancer and other illnesses

Chernobyl was poorly designed and improperly operated. The plant required constant human attention to keep the reactor from malfunctioning

3. What happened in Japan in March 2011?

On Friday, March 11, 2011, [Japan](#) experienced the largest [earthquake](#) in modern history. A programmed response at the country's Fukushima-Daiichi nuclear facility immediately descended on all of the reactor's control rods, shutting down all fission reactions within 10 minutes. Unfortunately, however, you can't shut down all radioactivity with the flip of a switch.

As we explored on the previous page, nuclear waste continues to generate heat years after its initial run in a power plant. Similarly, within the first few hours after a nuclear reactor shuts down, it continues to generate heat from the decay process.

The March 2011, quake manifested a deadly [tsunami](#), which destroyed the backup diesel generators that powered the water coolant pumps the facility had turned to after it couldn't get power from Japan's grid. These pumps circulate water through the reactor to remove decay heat. Uncirculated, both the water temperature and water pressure inside the reactor continued to rise. Furthermore, the reactor radiation began to split the water into oxygen and volatile hydrogen. The resulting hydrogen explosions breached the reactor building's steel containment panels

4. Why didn't the safety measures stop radioactivity at the plant?

nuclear waste continues to generate heat years after its initial run in a power plant. Similarly, within the first few hours after a nuclear reactor shuts down, it continues to generate heat from the decay process.

Task 3: Use the site below to investigate the pros and cons of nuclear energy

Go to: <http://www.howstuffworks.com/nuclear-power.htm>

1. What are the pros of nuclear power plant?

It doesn't depend on [fossil fuels](#) and isn't affected by fluctuating oil and gas prices. Coal and [natural gas](#) power plants emit carbon dioxide into the atmosphere, which contributes to [climate change](#). With nuclear power plants, CO2 emissions are minimal, though uranium mining, construction of reactors, transportation of fuel and other parts of nuclear energy do generate greenhouse gases

In fact, a properly functioning nuclear power plant actually releases less radioactivity into the atmosphere than a coal-fired power plant.

Nuclear fission produces roughly a million times more energy per unit weight than fossil fuel

2. What are the cons of nuclear power plant?

mining and purifying uranium hasn't been a very clean process. Even transporting nuclear fuel to and from plants poses a contamination risk.

And once the fuel is spent, you can't just throw it in the city dump. It's still radioactive and exposure to this waste can cause radiation sickness, cancer or even death, depending on how much radiation you absorb

nuclear power plants produce a great deal of low-level radioactive waste in the form of shoe covers, wiping rags, equipment and other materials

Task 4: Write a brief summary of your findings including the following:

1. How nuclear energy works

2. Pros and cons of using nuclear energy

3. Your opinion on the use of nuclear energy. Do you think we should continue/use more nuclear power as opposed to other sources such as fossil fuels? Why or why not?