

Lesson 6: NUCLEAR PHYSICS

(adapted from: Shipman et al, *An Introduction to Physical Science*, Houghton Mifflin Company 2006.)

- I. **Read the text below and briefly summarise the content of each paragraph. Notice the verbs in italics – their context and collocations.**

The atomic nucleus and its properties have an important impact on our society. The nucleus is involved with archeological dating, diagnosis and treatment of cancer and other diseases, chemical analysis, radiation damage and nuclear bombs, the generation of electricity by nuclear energy and the subsequent disposal of nuclear waste, the formation of new elements, the shining of the Sun and other stars, and even the operation of common household smoke detectors.

A specific type of nucleus, such as ^{238}U or ^{14}C , is referred to as nuclide. Nuclides whose nuclei *undergo* spontaneous decay are called radionuclides. The spontaneous process of nuclei undergoing a change by *emitting* particles or rays is called radioactive decay or radioactivity. Radioactive nuclei can *disintegrate* in three common ways: alpha decay, beta decay and gamma decay.

Radionuclides have many uses in medicine, chemistry, biology, agriculture, and industry. For example, a radioactive isotope of iodine ^{123}I , is used in a diagnostic measurement of the thyroid gland. The patient is *administered* a prescribed amount, which is absorbed by the thyroid gland. This allows doctors to trace it as it is released into the bloodstream in the form of protein-bound iodine. Nuclear radiation also can be used to treat diseased cells. Focusing an intense beam of radiation from cobalt-60 on a cancerous tumour destroys its cells and thus *impairs* or halts its growth. In environmental studies, small amounts of radionuclides help *detect* groundwater movement through soil and trace the paths of industrial air and water pollutants. In agriculture, less than lethal doses of radioactivity were used to cause sterility in male Mediterranean fruit flies in California and Florida, where the flies were destroying crops.

Fission is the process in which a large nucleus is split into two intermediate-size nuclei, with the emission of neutrons and the conversion of mass into energy. A bomb is an example of uncontrolled fission. A nuclear reactor is an example of controlled fission, in which we control the growth of the chain with reaction and the release of energy. The first commercial fission reactor for generating electricity went into operation in 1957 at Shippingport, Pennsylvania.

Fusion is the process in which smaller nuclei combine to form larger ones, with the release of energy. It is the source of energy of the Sun and other stars. About 600 million of tons of hydrogen are *converted* to 596 million tons of helium every second. The other 4 million tons of matter are converted into energy. Fortunately, the Sun has enough hydrogen to produce energy at its present rate for several billion more years.

II. Study the examples below and choose one word from the list for each group. There is one verb you do not need to use.

Disintegrate Undergo Emit Convert Administer Impair Detect

Group 1:

Hundreds of different types of hydrocarbons are from vehicle exhausts.

As a black hole particles, its mass and size steadily decrease.

If a female is of different species, she a buzz and the male flies off to try his luck elsewhere.

Group 2:

These tests are designed to early signs of neurological damage.

Ice telescopes could cosmic neutrinos.

The earlier the disease is, the better the outcome.

Group 3:

The material is highly flammable and prone to under anything but the most optimum storage conditions.

Even the nuclear family is The reason is the increasing emphasis on individualism.

The Soviet Union has into separate states.

Group 4:

Nowadays we say someone is "speech-.....", not dumb.

If innovation is stifled then efficiency of the markets may be

It was essential that their rights under the Constitution should in no way be

Group 5

Before operation all patients general physical examination.

Fresh plutonium slowly radioactive decay, making it unpredictable in warheads.

The system is currently testing.

Group 6

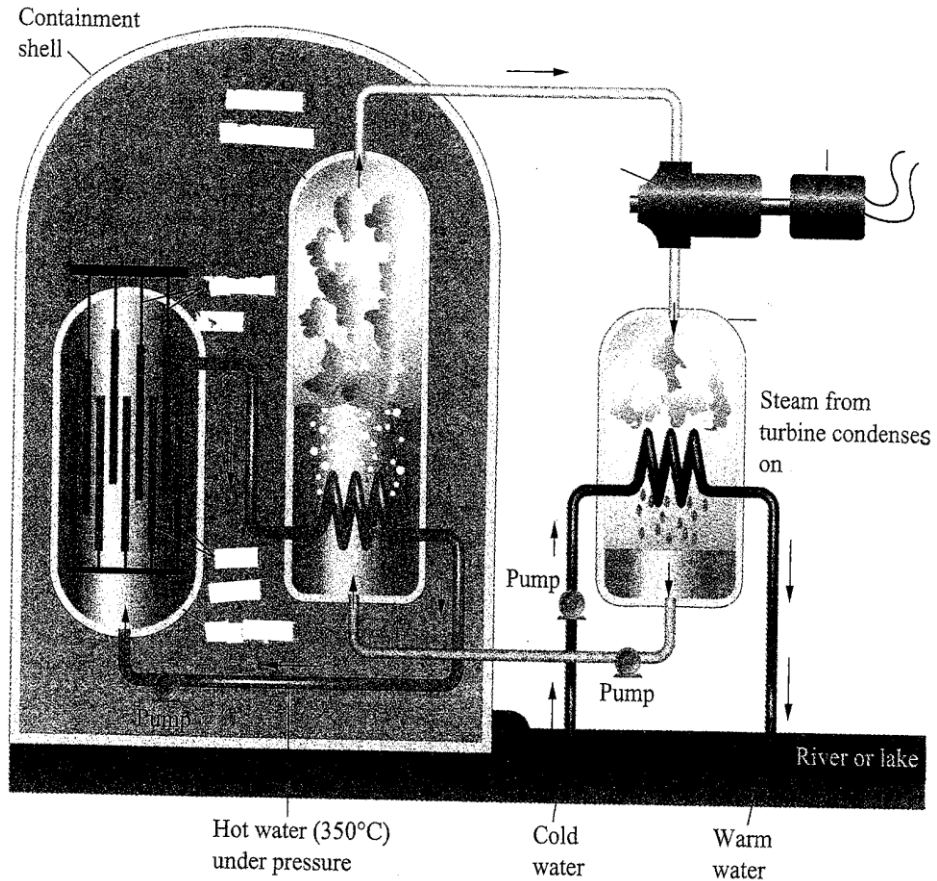
When I managed to my body into something trim and neat, my personality changed too.

The pulses of light passing through the slots to electrical signals by the photocells.

This is a means whereby analogue signals can be to digital and inputted to computer storage.

- III. Label the picture with the underlined words from the text, according to the information given.

A Light-Water Nuclear Reactor
Reactor
 The nuclear reactor consists of fuel rods with interspersed control rods. By raising or lowering the control rods, an operator can increase or decrease the rate of energy release from the fuel rods. Heat from the fuel rods raises the temperature of the liquid water in the reactor. A pump circulates the hot water to a steam generator, and the resulting steam passes through a turbine that operates an electric generator. The steam leaves the turbine and goes into the condenser, where it liquefies on the cooling coil. A nearby river or lake provides the cold water for the condenser. (From Ebbing, Darrell, *General Chemistry*, Seventh Edition. Copyright © 2002 by Houghton Mifflin Company. Used with permission.)



- IV. Think of nuclear power as an alternative source of energy. What are its pros and cons? In your pairs, try to think of as many as possible.
- V. Read the text and choose the most suitable word for each gap.

NUCLEAR POWER AND WASTE DISPOSAL

In making reasoned judgements about nuclear power, we must consider not only the benefits and drawbacks of fission and fusion power but also the benefits and drawbacks of other power sources, *although/because/unless* all power sources have drawbacks.

Unlike coal, oil, and natural gas, nuclear power does not emit carbon dioxide and other greenhouse gases that can cause global warming. Neither does it produce the sulphur oxides and nitrogen oxides that cause acid rain. *Neither/ or /nor* does it require drilling in environmentally sensitive areas. *Although / moreover / however* nuclear power has its drawbacks.

In recent years, the safety of nuclear reactors has increased to the point where the risks associated with them are exceedingly small. *However / although/ because* the true Achilles' heel of nuclear power is the highly toxic radioactive waste produced by fission power plants. The waste must be stored where it will be isolated from living creatures for tens of thousands of years.

In case / As regards/ It seems that the only viable solution to nuclear waste disposal is to bury it deep underground in geologically stable formations that can keep it isolated from the atmosphere and groundwater.

Now write your own sentences about nuclear power starting with

Unless...

Although...

Despite...

As regards...

In case...

VI. Your country is considering building another nuclear power plant. Imagine you are a member of a special council whose job is to decide whether or not such a plant should be built. You will work in two groups, for or against building the plant.

- Together with other people from your group prepare arguments backing up your standpoint.
- Think of possible counter-arguments of the second group and the way to counter them.
- Use these phrases to help you:

<p>Giving reason and supporting your opinion</p>	<ul style="list-style-type: none"> • To start with • The reason why • Many people think • Considering... • Allowing for the fact • When you consider that
<p>Connecting supporting points</p>	<ul style="list-style-type: none"> • In addition • Another point is that

	<ul style="list-style-type: none"> • Another consideration is • I should also add that
Asking for support or details	<ul style="list-style-type: none"> • Why do you think that? • Could you elaborate? • Could you give me an example? • Could you provide some details? • What evidence do you have?
Expressing disagreement	<ul style="list-style-type: none"> • I'm afraid I don't agree • I'm afraid I don't share your opinion • That's not always true/the case • Not necessarily • I'm not sure I agree with you • Shouldn't we consider... • But what about... • The problem with your point of view is that

VII. Nuclear power can be misused , for example as a weapon. Watch the video describing the circumstances leading to the production of the first nuclear bomb (source: <http://www.history.com/videos/bombing-of-hiroshima-and-nagasaki/#einstein-einstein-and-the-atom-bomb>) and fill in the gaps in its summary with suitable information.

Albert Einstein was against 1_____ to the army, as he hated the war. He said that his 2_____ was an instinctive feeling rather than an attitude derived from any 3_____. It was based, according to him, on his 4_____ to every kind of cruelty and 5_____.

In the 6_____ he was visited by two 7_____ to America. One of them, a 8_____ physicist Leo Szilárd had developed a theory enabling to build a nuclear bomb of 9_____ that mere threats of its 10_____ could stop the war, provided that the 11_____ would build it before the Nazis. This argument Einstein could not 12_____. Einstein realized that Hitler's regime aimed not only at 13_____ but also at putting 14_____ on the planet and extinguishing any others that were against it. The fear of the Nazis getting the weapon first was the only reason why he thought the atomic bomb should be built and encouraged Roosevelt to build it. Nevertheless, till the end of his life he worked on bringing the nuclear weapons 15_____.

What do you think about Einstein's decision? Was there really no other choice? What would you do if you were in his position?

