Edgenuity

Warm-Up | Types of Radioactive Decay

Lesson Objectives

By the end of this lesson, you should be able to:

- Differentiate between chemical reactions and nuclear reactions.
- Identify types of radioactive decay.

Science Practice: Translate technical information expressed in words in a text about nuclear radiation into a visual form, such as a table, to compare the different types of radiation.

Words to Know

Fill in this table as you work through the lesson. You may also use the glossary to help you.

alpha decay	the radioactive decay of an atom that emits an alpha particle
beta decay	the radioactive decay of an atom that emits an electron or a positron
gamma decay	the radioactive decay of an atom that emits a photon
photon	the smallest possible quantity of light
alpha particle	a particle with two protons and two neutrons
radioactive decay	the spontaneous release of energy and particles from the nucleus of an unstable atom
radiation	the high-energy particles emitted by an unstable nucleus as it decomposes
positron	a positively charged electron

Instruction | Types of Radioactive Decay

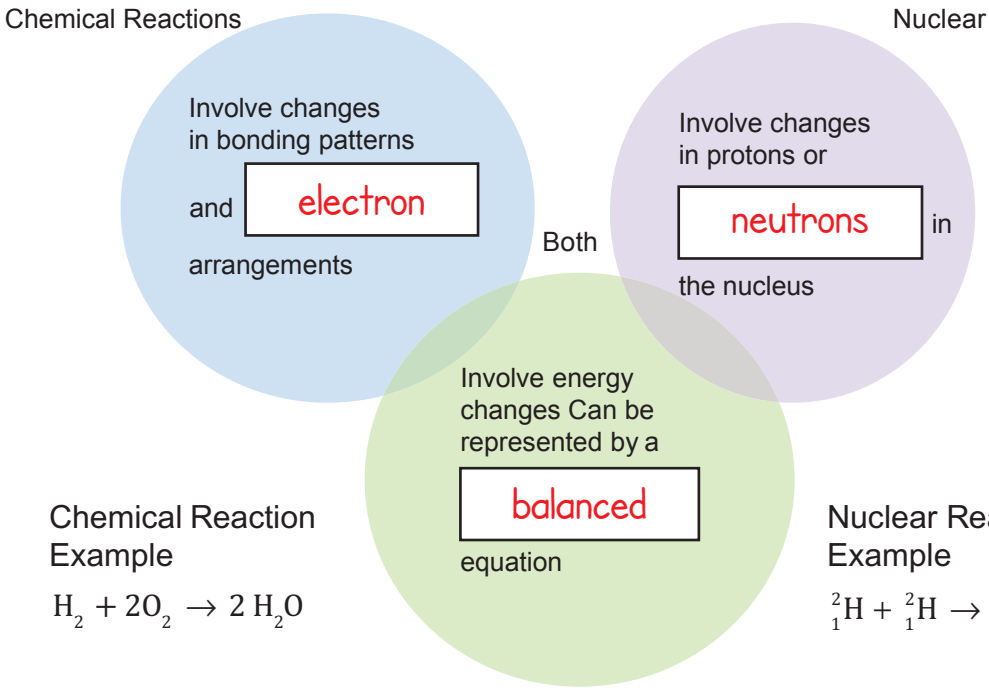
Slide 1

Lesson Question

What particles do unstable nuclei release to become stable?

Slide 2

Chemical Reactions and Nuclear Reactions



Chemical Reaction Example

$H_2 + 2O_2 \rightarrow 2\,H_2O$

Nuclear Reaction Example

$^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + {}^{1}_{0}n$

Instruction | Types of Radioactive Decay

Slide 5

Isotopes in Chemical and Nuclear Reactions

Isotopes in chemical reactions:

- show similar behavior.
- produce the same chemical [compounds].

Example:

$H_2 +$ [2] $O_2 \rightarrow 2H_2O$

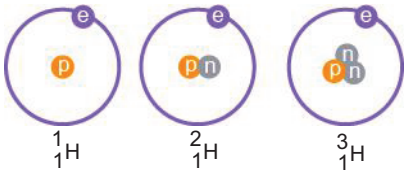
Isotopes in nuclear reactions:

- show different behavior.
- produce different [products].

Example:

$^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + {}^{1}_{0}n$

$^{1}_{1}H + {}^{1}_{1}H \rightarrow {}^{2}_{1}H + {}^{0}_{1}e$



$^{1}_{1}H$ $^{2}_{1}H$ $^{3}_{1}H$

Slide 7

Energy Changes in Chemical Reactions and Nuclear Reactions

Chemical Reactions

- [Exothermic] and endothermic
- Small [energy] changes

Example: $H_2 + 2O_2 \rightarrow 2H_2O$

releases 2.42×10^5 J/mol of water formed

Nuclear Reactions

- Exothermic and [endothermic]
- Large energy changes

Example: $^{1}_{1}H + {}^{1}_{1}H \rightarrow {}^{2}_{1}H + {}^{0}_{1}e$

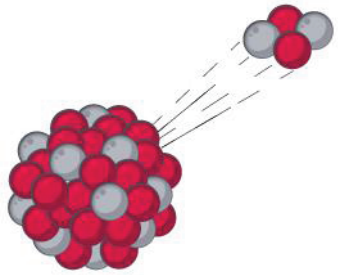
releases 1.0×10^{10} [J/mol] of deuterium formed

Instruction | Types of Radioactive Decay

Slide 10

Radioactive Decay

Radioactive decay is the process in which an unstable nucleus loses energy by emitting energy and particles.



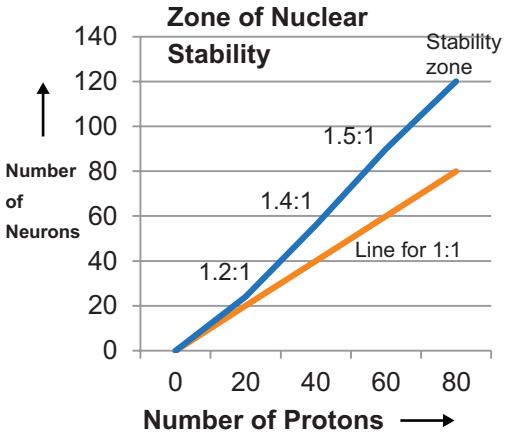
The energy given off by an unstable nucleus is called [radiation].

- Nucleus achieves greater stability
- Elemental identity of [nucleus] changes

Example: $^{238}_{92}\mathrm{U} \rightarrow {}^{234}_{90}\mathrm{Th} + {}^{4}_{2}\mathrm{He}$

The Cause of Radioactive Decay

- [Nuclear] stability:
  - depends on [neutron:proton] ratio.
  - depends on size of nucleus.
- As the size of the nucleus increases, a greater ratio of neutrons to protons is needed to stabilize the nucleus.
- Large nuclei with [84] or more protons are not stable.



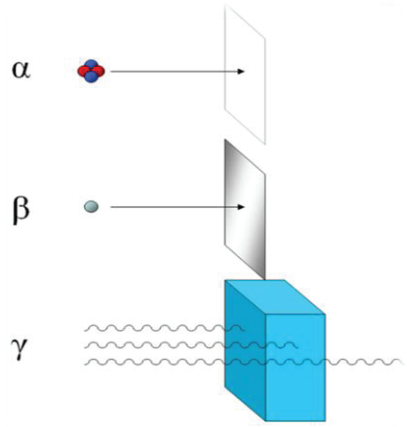
Instruction | Types of Radioactive Decay

Slide 12

Types of Radioactive Decay

Alpha **decay**

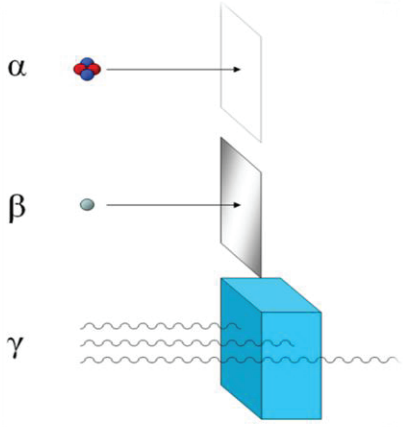
- Emission of **alpha** particle, which contains two neutrons and two protons
  - Alpha particles represented by $^{4}_{2}\mathrm{He}$
- Least penetrating; cannot penetrate paper



Types of Radioactive Decay

Beta **decay**

- Emission of electron or **positron** (an electron with a positive charge), both have a charge but negligible mass
- Can penetrate paper but not metal foil



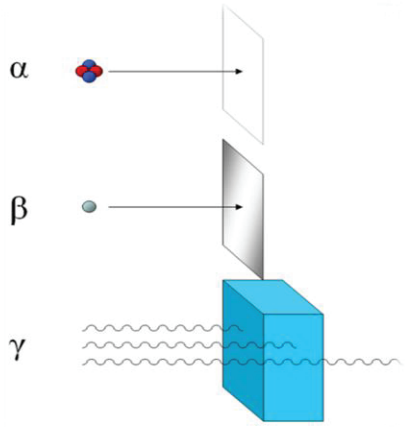
Instruction | Types of Radioactive Decay

Slide 12

Types of Radioactive Decay

Gamma **decay**

- Emission of photon (the smallest possible quantity of light), which has no charge or mass
- Highest energy; requires thick lead to shield



Characteristics of Radioactive Decay

	Alpha Decay	Beta Decay	Gamma Decay
Radiation	alpha particles	electrons or positrons	gamma rays
Charge	+2	electron: −1 positron: +1	0
Mass	large	very small	none
Penetrating power	low	medium	high
Shielding	paper	thin metal sheet	thick lead walls

Each emission type has a unique charge, mass, penetrating power, and type of shielding needed to protect a human from exposure.

Summary | Types of Radioactive Decay

Lesson Question

What particles do unstable nuclei release to become stable?

Answer

(Sample answer) The particles released by the unstable nuclei to become stable are alpha particles, electrons, positrons, and gamma rays.

Slide 2

Comparing Chemical Reactions and Nuclear Reactions

	Chemical reactions:	Nuclear reactions:
SIMILARITIES	can be represented by a balanced equation.	
	can be either exothermic or endothermic.	
DIFFERENCES	involve changes to bonds and electron arrangements.	involve changes to protons and neutrons in the nucleus.
	result in new chemical compounds.	result in new elements.
	are not affected by using different isotopes.	are affected by using different isotopes.
	involve small energy changes.	involve large energy changes.

Summary | Types of Radioactive Decay

Slide 2

Types of Radioactive Decay

Alpha decay:

- emits alpha particles (+2).
- has large mass.
- has low penetrating power.
- requires very little shielding.

Beta decay:

- emits electrons (–1) or positrons (+1).
- has very small mass.
- has some penetrating power.
- requires some shielding.

Gamma decay:

- emits gamma rays (no charge).
- has no mass.
- has high penetrating power.
- requires lead shielding.

Use this space to write any questions or thoughts about this lesson.