

Name _____ Section _____

Period 9 Activity Sheet: Ionizing Radiation

9.1 What is Ionizing Radiation?

Your instructor will discuss ionizing radiation.

1) Defining ionizing radiation

How does ionizing radiation differ from other types of radiation, such as microwaves, infrared radiation, or visible light?

2) Types of ionizing radiation

- a) What is an alpha particle (α) composed of? What is the electric charge of an alpha particle?

- b) What are the two types of beta particles (β) composed of? What is the electric charge of each type of beta particle?

- c) What is a gamma particle (γ) composed of? Do gamma particles have an electric charge?

- d) Which type of electromagnetic radiation has the most ionizing ability? Why?

9.2 How is Ionizing Radiation Detected?

3) Detecting ionizing radiation

Your instructor will show you how to operate the Geiger counters and the timers.

- a) Perform a count of background radiation in the room by counting the number of clicks (events) every minute. What is the background level of counts/minute?

- b) What is the source of this background radiation?

4) The strength of ionizing radiation

Your instructor will bring you a weak radioactive source. Attach the Geiger counter detector to a ring stand. Place the source 10 cm from the open side of the detector and record the number of counts per minute.

- a) How many counts per minute result from this source? _____
- b) Place the source 20 cm from the detector and record the number of counts per minute. _____
- c) Place the source 40 cm from the detector and record the number of counts per minute. _____
- d) What effect does increasing the distance have on the count?

5) The Penetrating ability of ionizing radiation

Your instructor will give you three weak radioactive sources that emit alpha, beta, or gamma particles. Test the penetrating ability of each type of ionizing radiation by placing the sources, one at a time, approximate 10 cm from the open side of the Geiger counter detector. Try shielding each source with pieces of cardboard, aluminum, and lead. Write "yes" or "no" in the table below to indicate which materials shielded each source.

Does the shielding material significantly reduce the ionizing radiation recorded by the Geiger counter?

| Shielding material | alpha | beta | gamma |
|-----------------------------|-------|-------|-------|
| a) cardboard | _____ | _____ | _____ |
| b) one aluminum sheet | _____ | _____ | _____ |
| c) multiple aluminum sheets | _____ | _____ | _____ |
| d) one lead sheet | _____ | _____ | _____ |
| e) multiple lead sheets | _____ | _____ | _____ |

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9.3 Why Do Nuclei Decay?

6) Source of ionizing radiation

What is the source of ionizing radiation?

7) Unstable large nuclei

- a) Why are large nuclei with more than 82 protons unstable?

- b) Which type of radioactive decay (α , β , or γ) would reduce the size of a nucleus?

- c) What happens to the identity of the nucleus after this type of decay?

8) Unstable small nuclei

- a) Why are some isotopes of small nuclei unstable?

- b) Which type of radioactive decay (α , β , or γ) would make such isotopes more stable?

- c) What happens to the identity of the nucleus after this type of decay?

- d) What happens to the total number of nucleons after this type of decay?

9) Neutrinos

- a) What is a neutrino?

- b) Which type of neutrino is emitted when an electron (β^-) is emitted? _____
- c) Write the equation for the nuclear reaction that occurs when a neutron emits an electron and becomes a proton.

- d) Which type of neutrino is emitted when an antielectron (β^+) is emitted? _____
- e) Write the equation for the nuclear reaction that occurs when a proton emits an antielectron and becomes a neutron.

9.4 How do Unstable Nuclei Decay?

10) Conservation laws

- What is conservation of charge? How does this conservation law apply to a nuclear reaction?

- What is conservation of nucleon number? How does this conservation law apply to a nuclear reaction?

11) Nuclear decay

Fill in the table below, which summarizes the properties of the types of ionizing radiation.

| Radiation | Particle emitted | A = # of nucleons | Z = # of protons | Electric Charge |
|--------------------|------------------|-------------------|------------------|-----------------|
| alpha (α) | | | | |
| beta (β^-) | | | | |
| beta (β^+) | | | | |
| gamma (γ) | | | | |

12) Nuclear reactions

Use the conservation laws and the information in the nuclear decay table to answer the questions below.

- In a nuclear reaction, potassium-40 (${}_{19}^{40}\text{K}$) decays by emitting one electron. Write an equation that describes this nuclear reaction.

- Thorium-232 (${}_{90}^{232}\text{Th}$) decays into radon-228 (${}_{88}^{228}\text{Ra}$) and emits a particle of ionizing radiation. Write an equation that describes this nuclear reaction.

- Uranium-238 decays by emitting an alpha particle. Write an equation that describes this reaction. Which element is formed after this decay?