

# LESSON 2.3 – ANALYZING NUCLEAR REACTIONS

## EVIDENCE NOTEBOOK

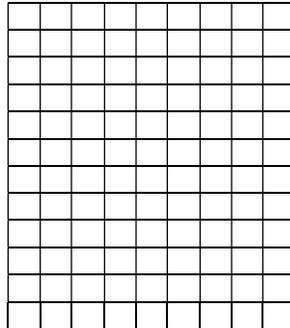
### KEY IDEAS

1. Nucleus
  - a. What are the two subatomic particles in an atom's nucleus?
  
  - b. What are the charges of these subatomic particles?
  
  - c. What attracts the subatomic particles together?
  
  - d. What force causes the nucleus to break apart?
  
  - e. After \_\_\_\_\_ nuclei, the \_\_\_\_\_ force overpowers the \_\_\_\_\_ force and we start to see more radioactive elements.
2. Radiation
  - a. What is an alpha particle composed of?
  
  - b. What is a beta particle composed of?
  
  - c. What is a gamma ray?
  
  - d. How does radioactive penetrating power relate to mass?

3. Uranium-238 undergoes radioactive decay to produce thorium-234 and an alpha particle.
  - a. Complete the radioactive decay equation by alpha emissions:
  
  - b. When an atom loses an alpha particle:
    - i. the *atomic number* \_\_\_\_\_, becoming a new element.
    - ii. the *atomic mass* \_\_\_\_\_.
4. Carbon-14 undergoes radioactive decay to produce nitrogen-14 and a beta particle.
  - a. Complete the radioactive decay equation by beta emissions:
  
  - b. When an atom loses a beta particle:
    - i. the *atomic mass* \_\_\_\_\_.
    - ii. the *atomic number* \_\_\_\_\_.
5. Gamma radiation:
  - a. Charge:
  - b. Mass:
  - c. Often emitted along with \_\_\_\_\_.
6. Write the equation to represent the decay of radium-226 by  $\alpha$  emission.
7. Write the equation to represent the decay of plutonium-244 by  $\alpha$  emission.
8. The decay products from a nuclear reaction are an  $\alpha$  particle and polonium-218. What is the parent nuclide in this reaction?
9. Write the equation to represent the decay of radium-226 by  $\beta$  emission.
10. Write the equation to represent the decay of plutonium-240 by  $\beta$  emission that also releases gamma radiation.

11. Half-life

- a. Half-life definition:
  
  
  
  
  
  
  
  
  
  
- b. Create a graph consisting of 7 half-lives:



12. Fusion

- a. Define nuclear fusion:
  
  
  
  
  
  
  
  
  
  
- b. Name two common isotopes of hydrogen that are commonly used in fusion reactions:
  
  
  
  
  
  
  
  
  
  
- c. Illustrate a fusion reaction:
  
  
  
  
  
  
  
  
  
  
- d. Where are fusion reactions most common?

13. Fission

- a. Define nuclear fission
- b. Beside making two smaller elements, what else is produced during nuclear fission?
- c. Illustrate a fission reaction:

14. Nuclear reactors

- a. Fuel elements:
- b. Moderator:
- c. Control Rods:
- d. Illustration a nuclear reactor with the following components included and labeled:  
*Reactor core, moderator liquid, concrete shield, heat exchanger, electrical producing turbine, water (flow direction), steam (flow direction), pumps.*

## CHECKPOINTS

15. *Select the correct terms to complete the statement.*

In fission, nuclei break apart | join. This reaction is found spontaneously in nuclides with few | many nucleons. In fusion, nuclei break apart | join. This reaction is possible when energy is added to | released from nuclei with few | many nucleons.

16. Which force repels like charges from each other?

- a. Gravitational
- b. Electromagnetic
- c. Strong
- d. Weak

17. Which of the following are conserved in all nuclear reactions? *Select all correct answers.*

- a. mass
- b. charge
- c. number of protons
- d. number of neutrons
- e. number of nucleons

18. Match the following:

Alpha decay	$\gamma$
Beta decay	${}^4_2\text{He}$
Gamma emission	${}^0_{-1}e$

19. What is an alpha particle made of?

- a. Two protons and two electrons
- b. Two protons and two neutrons
- c. One proton and one electron
- d. One proton and one neutron

20. If a 100 g sample of an isotope with a half-life of 10 years decays from 20 years, what is the remaining mass of isotope?

- a. 0 g
- b. 10 g
- c. 25 g
- d. 50 g

21. What do control rods do in a nuclear reactor?
- They cool the reactor
  - They slow down the neutrons
  - They absorb some free neutrons
  - They protect against radioactivity
22. Which statement describes the relationship between the use of nuclear energy as a fuel source and economic considerations that must be made when using it?
- Nuclear energy is the best economic decision as a fuel source because nuclear fission produces no pollutants or greenhouse gases.
  - Because a small pellet of uranium produces the same amount of energy as burning 900 kg of coal, nuclear energy is a significantly better economic choice.
  - Nuclear energy is the most profitable energy for the future since nuclear energy is safe, clean, and reliable energy that can be used in thermoelectric batteries in space.
  - While nuclear energy produces clean, reliable energy, the fuel cycle of uranium requires heavy use of fossil fuels to mine and process it, which affects the economic viability.
23. When a negatively charged beta particle is emitted by a radioactive nucleus, which change happens in the nucleus?
- The number of protons increases by one
  - The number of neutrons increases by one
  - The number of nucleons increases by one
  - The number of protons decreases by one
24. Which process describes a nuclear fusion reaction?
- A heavy nucleus absorbs energy to produce lighter nuclei.
  - A heavy nucleus splits to produce energy and lighter nuclei.
  - Two heavy nuclei bind together to produce energy and heavier nuclei.
  - Two light nuclei bind together to produce energy and a heavier nucleus.
25. Which statement is true about nuclear fission?
- Fission does not naturally occur on Earth.
  - Fission increases the mass of each nucleus involved.
  - Fission is the primary process that produces energy in stars.
  - Fission produces nuclei that are more stable than the original nuclei.

26. Write the equation to represent the decay of boron-12 by beta emission.
27. Write the equation to represent the decay of actinium-225 by alpha emission.
28. The decay products from a nuclear reaction are a beta particle and copper-63. What is the parent nuclide in this reaction?