Balancing Nuclear Equations

Name: _____ Period: _____

There are two types of nuclear reactions: Fission, where a nucleus breaks into two or more pieces, and fusion where two or more nuclei combine to form a new element. In nuclear reactions, only the nucleus is involved. Electrons are ignored. Some atomic nuclei are inherently unstable and spontaneously change or "decay". There are four types of decay:

Type	Symbol	Charge of particle	Mass(AMU)	Effect on Atomic #	Effect on Atomic Mass	Strength
Alpha	α	+2 (He nucleus)	4	decrease by 2	decrease by 4	Stopped by paper
Beta- e- emission	β- electron	-1	0	increase by 1	0	Aluminum Foil
Beta+ e- capture	β+ Positron	+1	0	decrease by 1	0	Aluminum Foil
Gamma	γ	none	none	none	none	Lead

The net result of α, β- or β+ decay is a new element. In b- decay, a neutron decays into a p+ and an e- which is then ejected. In β+ decay a p+ captures an e- and transforms into a neutron. But despite the nature of the reaction the law of conservation of matter still applies and the equations are balanced the same way. Note α particle is a helium nucleus!

Another type of reaction occurs when something impacts a nucleus. These reactions result either in the nucleus splitting (fission) or the combination of two or more nuclei to form a third, different nucleus (fusion).

Balancing Nuclear Equations: Matter must be conserved including all p+ & n°. Example:

Decay reaction (α decay) $^{219}_{86}Rn \rightarrow ^{4}_{2}He + ^{215}_{84}Po$

Fission Reaction $^{1}_{0}n + ^{235}_{92}U \rightarrow ^{92}_{36}Kr + ^{141}_{56}Ba + 3^{1}_{0}n$

Fusion Reaction: $^{35}_{17}Cl + ^{1}_{1}H \rightarrow ^{36}_{18}Ar$ another example $^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + n^{\circ}$

Practice

Fill in the missing symbol and name the reaction:

1. $^{3}_{1}H \rightarrow$ _____ $+ ^{0}_{-1}e$ _____

2. $^{232}_{92}U \rightarrow ^{228}_{90}Th +$ _____ _____

3. $^{144}_{58}Ce \rightarrow ^{144}_{59}\mathrm{Pr} +$ _____ _____

4. $^{65}_{30}Zn \rightarrow$ _____ $+ ^{0}_{+1}e$ _____

5. $^{40}_{19}K \rightarrow ^{40}_{18}Ar +$ _____ _____

6. ${}^{7}_{4}Be \rightarrow {}^{7}_{4}Be +$ _____ _____

7. ${}^{1}_{0}n + {}^{235}_{92}U \rightarrow$ _____ $\rightarrow {}^{141}_{55}Cs + {}^{92}_{37}Rb +$ _____ _____

8. ${}^{222}_{86}Rn \rightarrow$ _____ $+ {}^{4}_{2}He$ _____

9. ${}^{129}_{53}I \rightarrow {}^{129}_{54}Xe +$ _____ _____

10. ${}^{239}_{94}Pu \rightarrow$ _____ $+ {}^{4}_{2}He$ _____

11 ${}^{15}_{8}O \rightarrow {}^{15}_{7}N +$ _____ _____

12. Write a balanced nuclear equation for each decay process indicated.

a. The isotope Th-234 decays by an alpha emission.

b. The isotope Fe-59 decays by a beta emission.

c. The isotope Tc-99 decays by a gamma emission.

d. The isotope C-11 decays by a electron capture.

Balance these equations: Note ${}^{4}_{2}He$ is the only stable isotope of helium.

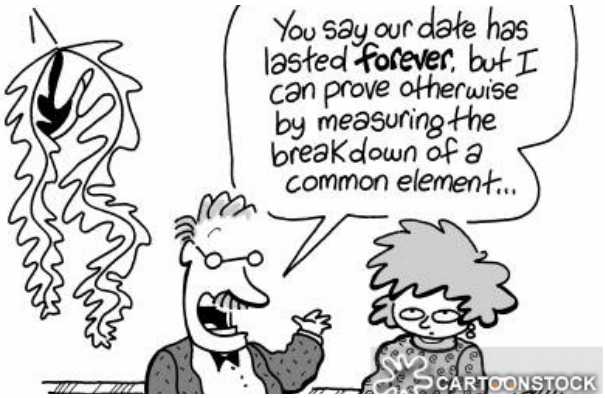
13. ${}^{1}_{1}H + {}^{7}_{3}Li \rightarrow$ _____

14. ${}^{7}_{4}Be + n^{\circ} \rightarrow$ _____H + _____He

15. What is the balanced nuclear equation for the reaction of curium-246 with carbon-12 to produce nobelium-254 and four neutrons?

16. What is the balanced nuclear equation for the reaction of californium-250 with boron-10 to produce lawrencium-258 and two neutrons?

1. Define half-life.
2. How is the half-life of a radioisotope similar to a sporting tournament in which the losing team is eliminated?
3. The half-life of radium-226 is 1600 years. If a sample of radium-226 has an original activity of 200 Bq, what will its activity be after 4800 years?
4. Sodium-24 has a half-life of 15 hours. If a sample of sodium-24 has an original activity of 500 Bq, what will its activity be after 60 hours?
5. After 42 days the activity of a sample of phosphorus-32 has decreased from 400 Bq to 50 Bq. What is the half-life of phosphorus-32?
6. The half-life of radon-222 is 3.8 days. What was the original activity if it has an activity of 10 Bq after 7.6 days?
7. The half-life of thorium-227 is 19 days. How many days are required for 75% of a sample to decay?
8. The half-life of protactinium-234 is 6.75 hours. What percentage of a sample will remain after 27 hours?
9. A rock once contained 1.0 mg of uranium-238, but now contains only 0.25 mg. Given that the half-life for uranium-238 is 4.5×10^9 (4.5 billion) years, how old is the rock?
10. The half-life of tritium (hydrogen-3) is 12.3 years. If 48.0 mg of tritium is released from a nuclear power plant during the course of a mishap, what mass of the sample will remain after 49.2 years?



Nuclear Reaction Worksheet

Complete the following equations.

1. $^{212}_{84}Po \rightarrow {}^{4}_{2}He +$
2. $^{142}_{61}Pm + \rightarrow {}^{142}_{60}Nd$
3. $^{253}_{99}Es + {}^{4}_{2}He \rightarrow {}^{1}_{0}n +$
4. $^{218}_{84}Po \rightarrow {}^{4}_{2}He +$
5. $^{9}_{4}Be + {}^{4}_{2}He \rightarrow + {}^{1}_{0}n$
6. $^{22}_{11}Na + \rightarrow {}^{22}_{10}Ne$
7. $^{238}_{92}U \rightarrow + {}^{234}_{90}Th$
8. $^{37}Ar + \rightarrow {}^{37}_{17}Cl$
9. Write the nuclear equation for the decay of Po-210 if it undergoes 2 consecutive alpha decays followed by a Beta decay followed by another alpha decay.

10. Write the nuclear equation for the release of a beta particle by Pb-210.

11. Thorium-232 undergoes radioactive decay until a stable isotope is reached. Write the reactions for the decay of Th-232. There are eleven steps beginning with Alpha decay with each product becoming the reactant of the next decay. Circle the final Stable isotope.

    - Alpha:
    - Beta:
    - Beta:
    - Alpha:
    - Alpha:
    - Alpha:
    - Alpha:
    - Beta:
    - Beta:
    - Alpha:
    - Beta:

12. An isotope of cesium (cesium-137) has a half-life of 30 years. If 1.0 mg of cesium-137 disintegrates over a period of 90 years, how many mg of cesium-137 would remain?

13. A 2.5 gram sample of an isotope of strontium-90 was formed in a 1960 explosion of an atomic bomb at Johnson Island in the Pacific Test Site. The half-life of strontium-90 is 28 years. In what year will only 0.625 grams of this strontium-90 remain?

14. Actinium-226 has a half-life of 29 hours. If 100 mg of actinium-226 disintegrates over a period of 58 hours, how many mg of actinium-226 will remain?

15. Thallium-201 has a half-life of 73 hours. If 4.0 mg of thallium-201 disintegrates over a period of 6.0 days and 2 hours, how many mg of thallium-201 will remain?

16. Sodium-25 was to be used in an experiment, but it took 3.0 minutes to get the sodium from the reactor to the laboratory. If 5.0 mg of sodium-25 was removed from the reactor, how many mg of sodium-25 were placed in the reaction vessel 3.0 minutes later if the half-life of sodium-25 is 60 seconds?

17. The half-life of isotope X is 2.0 years. How many years would it take for a 4.0 mg sample of X to decay and have only 0.50 mg of it remain?

18. Selenium-83 has a half-life of 25.0 minutes. How many minutes would it take for a 10.0 mg sample to decay and have only 1.25 mg of it remain?

19. Element-106 has a half-life of 0.90 seconds. If one million atoms of it were prepared, how many atoms would remain after 4.5 seconds?

20. The half-life of Po-218 is three minutes. How much of a 2.0 gram sample remains after 15 minutes? Suppose you wanted to buy some of this isotope, and it required half an hour for it reach you. How much should you order if you need to use 0.10 gram of this material?

Below are several fission reactions. Please fill in the missing portions.

21. $^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Ba} + \quad + 3{}^{1}_{0}\mathrm{n}$

22. $^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{137}_{52}\mathrm{Te} + \quad + 2{}^{1}_{0}\mathrm{n}$

23. $^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow \quad + {}^{137}_{55}\mathrm{Cs} + 3{}^{1}_{0}\mathrm{n}$

24. $^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{94}_{38}\mathrm{Sr} + {}^{140}_{54}\mathrm{Xe} + {}^{1}_{0}\mathrm{n}$

25. $\quad + {}^{1}_{0}\mathrm{n} \rightarrow {}^{144}_{58}\mathrm{Ce} + {}^{94}_{36}\mathrm{Kr} + 2{}^{1}_{0}\mathrm{n}$