**Summative 3.1, 3.4, 3.5 Study Guide – Isotopes, Radioactivity & Half-Lives – ANS KEY**

**Learning Target 3.1**

1. Complete the table for the following ISOTOPES.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Element | Hyphen Notation | Atomic # | Atomic Mass | # protons | # neutrons | # electrons | Nuclear Symbol  |
| Vanadium | Vanadium - 51 | 23 | 51 | 23 | 28 | 23 | $\begin{matrix}51\\23\end{matrix}$V |
| Vanadium | Vanadium-52 | 23 | 52 | 23 | 29 | 23 | $\begin{matrix}52\\23\end{matrix}$V |
| Lead | Lead - 209 | 82 | 209 | 82 | 127 | 82 | $\begin{matrix}209\\82\end{matrix}$Pb |
| Silver | Silver – 109  | 47 | 109 | 47 | 62 | 47 | $\begin{matrix}109\\47\end{matrix}$Ag |

**Learning Target 3.4**

1. Define Radioactivity.

The breakdown of an unstable radioactive isotope’s nucleus to release a decay particle and become a new, more stable isotope/element.

1. There are 4 types of radioactive decay – you need to memorize the particles! Describe the mass, charge, actual identity, and relative penetration power of the following radioactive particles:
	1. Alpha particles

$\begin{matrix}4\\ 2\end{matrix}$He Large, big charge, blocked by paper

* 1. Beta particles

$\begin{matrix}0\\-1\end{matrix}$e small, negative charge, blocked by wood/aluminum

* 1. Gamma particles

$\begin{matrix}0\\0\end{matrix}$Ɣ small, high energy, no charge, blocked by concrete/very thick lead

* 1. Positron particles

$\begin{matrix}0\\+1\end{matrix}$e small, positive charge, blocked by wood/aluminum

1. *For the following problems – write out the entire decay equation.*
	1. Alpha emission by plutonium-239, one of the substances formed in nuclear power plants.

$\begin{matrix}239\\94\end{matrix}$Pu 🡪 $\begin{matrix}4\\2\end{matrix}$He + $\begin{matrix}235\\92\end{matrix}$U

* 1. Beta decay by sodium-24, used to detect blood clots

$\begin{matrix}24\\11\end{matrix}$Na 🡪 $\begin{matrix}0\\-1\end{matrix}$e + $\begin{matrix}24\\12\end{matrix}$Mg

* 1. Oxygen-15 undergoes positron emission, used to assess the efficiency of the lungs.

$\begin{matrix}15\\8\end{matrix}$O 🡪 $\begin{matrix}0\\+1\end{matrix}$e + $\begin{matrix}15\\7\end{matrix}$N

* 1. Carbon-14 emits beta particles.

$\begin{matrix}14\\6\end{matrix}$C 🡪 $\begin{matrix}0\\-1\end{matrix}$e + $\begin{matrix}14\\7\end{matrix}$N

* 1. Thorium-232 goes through alpha decay.

$\begin{matrix}232\\90\end{matrix}$Th 🡪 $\begin{matrix}4\\2\end{matrix}$He + $\begin{matrix}228\\88\end{matrix}$Ra

* 1. Radium-226 emits gamma and alpha particles.

$\begin{matrix}226\\88\end{matrix}$Ra 🡪 $\begin{matrix}0\\0\end{matrix}$Ɣ + $\begin{matrix}4\\2\end{matrix}$He + $\begin{matrix}222\\86\end{matrix}$Rn

* 1. Chlorine-36 undergoes positron emission.

$\begin{matrix}36\\17\end{matrix}$Cl 🡪 $\begin{matrix}0\\+1\end{matrix}$e + $\begin{matrix}36\\16\end{matrix}$S

* 1. Argon-37 **is produced** by beta decay.

$\begin{matrix}37\\17\end{matrix}$Cl 🡪 $\begin{matrix}0\\-1\end{matrix}$e + $\begin{matrix}37\\18\end{matrix}$Ar

* 1. Fermium-257 **is formed** by alpha and gamma emission.

$\begin{matrix}261\\102\end{matrix}$No 🡪 $\begin{matrix}0\\0\end{matrix}$Ɣ + $\begin{matrix}4\\2\end{matrix}$He + $\begin{matrix}257\\100\end{matrix}$Fm

* 1. An isotope of rhenium-188 undergoes alpha decay.

$\begin{matrix}188\\75\end{matrix}$Re 🡪 $\begin{matrix}4\\2\end{matrix}$He + $\begin{matrix}184\\73\end{matrix}$Ta

* 1. A radioactive isotope undergoes beta and gamma decay to produce Chlorine-36.

$\begin{matrix}36\\16\end{matrix}$S 🡪 $\begin{matrix}0\\0\end{matrix}$Ɣ + $\begin{matrix}0\\-1\end{matrix}$e + $\begin{matrix}36\\17\end{matrix}$Cl

* 1. Radium-226 goes through decay to produce Radon-222.

$\begin{matrix}226\\88\end{matrix}$Ra 🡪 $\begin{matrix}4\\2\end{matrix}$He + $\begin{matrix}222\\86\end{matrix}$Rn

* 1. Lead-208 emits a positron to produce a stable isotope.

$\begin{matrix}208\\82\end{matrix}$Pb 🡪 $\begin{matrix}0\\+1\end{matrix}$e + $\begin{matrix}208\\81\end{matrix}$Tl

**Learning Target 3.5**

*For the following half-life problems, show all work, include units & round appropriately!*

1. One of the radioactive nuclides formed in nuclear power plants is hydrogen-3, called tritium, which has a half-life of 12.26 years. How long before a sample decreases to 1/8 of its original amount?

1 🡪 ½ 🡪 ¼ 🡪 1/8 3 half lives x 12.26 = 36.78 years

1. Uranium-238 is one of the radioactive nuclides sometimes found in soil. It has a half-life of 454 years. What percentage of a sample is left after 2270 years?

2270/454 = 5 half lives 100% 🡪 50 🡪 25 🡪 12.5 🡪 6.25 🡪 3.125 which rounds to 3.13%

1. Cesium-133, which is used in radiation therapy, has a half-life of 30 years. What was the size of the original sample if after 120 years you now have 16.0 grams?

120/30 = 4 half lives need to work backwards 256 🡪 128 🡪 64 🡪 32 🡪 16

 256 rounds to 300 grams

1. Phosphorus-32, which is used for leukemia therapy, has decayed to 1/16th of its original amount in 42.9 days. What is the half-life of phosphorous-32?

1 🡪 ½ 🡪 ¼ 🡪 1/8 🡪 1/16 took 4 half lives 42.9/4 = 10.725 rounds to 10.7 days

1. Iodine has a half-life of 8.07 days. Assuming you start with 90.5 grams, how much of the sample (**in mg**) would you have left after 24.21 days?

24.21/8.07 = 3 half lives 90.5 🡪 45.25 🡪 22.625 🡪 11.3125g x 1000 mg = 11312.5 rounds to 11300 mg

 1 g