

Name:_____ Key_____

Atomic Structure and Nuclear Chemistry

1. List the locations for each of the subatomic particles:
Protons and neutrons are in the nucleus and electrons outside the nucleus
2. List the charges associated with each subatomic particle.
Protons are positive, electrons are negatively charged, and neutrons are neutral
3. Atomic Number: Where is it found? What does this number represent?
Top corner or center; number of protons
4. Average Atomic Mass: Where is it found? What does this number represent?
Bottom; average mass of all isotopes of that element
5. Mass Number: What does this number represent?
Protons + neutrons of one specific isotope

Consider an atom based on the following: ${}^{20}_{9}\text{F}$

6. The top number represents: mass number. The bottom number represents: atomic number
7. # of Protons? 9 # of Neutrons? 11 # of Electrons 9
8. Is this atom the most common form of Fluorine? Explain why or why not:
No because the mass on the Periodic Table is 19
9. Forms of the same element that have different numbers of neutrons are: Isotopes
10. Explain what is happening in a chain reaction. What type of nuclear reaction is associated with chain reactions?
The products of a reaction continue to cause reactions. In fission reactions, the nucleus splits and this releases neutrons. The neutrons go on to split more nuclei
11. Explain what happens during a fusion reaction. Where do fusion reactions take place?
Two small nuclei fuse to form a larger nucleus. It takes place in the sun and other stars
12. Which type of nuclear reaction produces the most energy?
Fusion
13. List three examples of where the types of nuclear decay are used in helpful ways. (Not fission/fusion)
A) Cancer treatments
B) PET scan/tracers
C) Sterilizing equipment
D) Food preservation
14. What does the term radioactive mean? Do atoms stay radioactive forever?
Unstable nucleus; No they will decay until reach a stable nucleus
15. What are two types of background radiation? Cosmic rays and isotopes here in earth are radioactive
16. Give a thorough description of an alpha particle:
It has a mass of 4; 2 protons and 2 neutrons (no electrons). Resembles a helium nucleus.

17. Give a thorough description of a beta particle: **It resembles an electron in mass and charge with high energy**
18. What is an isotope? **An element with the same # of protons but different # of electrons** _____
19. What is the mass number for Oxygen-19? _____ **19** _____
20. How many neutrons does Oxygen-19 have? _____ **11** _____
21. What is the isotope notation for Oxygen-19? _____ **$^{19}_8\text{O}$** _____
22. What are two differences between Oxygen-17 and Oxygen-19? **Oxygen-19 has 2 more neutrons**
23. What is an ion? **an element that loss or gained electrons (charged element)** _____
24. What is a cation and give me an example of a cation? **a positive charged element; Na⁺** _____
25. What type of elements generally form cations? _____ **metals** _____
26. What is an anion and give me an example of an anion? _____ **a negative charged element; Cl⁻** _____
27. What type of elements generally form anions? _____ **nonmetals** _____
28. Write the equation for the alpha decay for these two elements
 A) $^{209}_{84}\text{Po} \rightarrow ^{205}_{82}\text{Pb} + ^4_2\text{He}$ B) $^{168}_{68}\text{Er} \rightarrow ^{164}_{66}\text{Dy} + ^4_2\text{He}$
29. Write the equation for the beta decay for these two elements
 A) $^{14}_6\text{C} \rightarrow ^{14}_7\text{N} + \text{beta}$ B) $^{80}_{35}\text{Br} \rightarrow ^{80}_{36}\text{Kr} + \text{beta}$
32. What is an example of an uncontrolled nuclear reaction? **A meltdown/atom bomb**
33. What is an example of a controlled nuclear reaction? **Using fission reactions in a nuclear power plant**
34. Complete the following nuclear equations.
 A) $^{28}_{13}\text{Al} \rightarrow$ **$^{28}_{14}\text{Si}$** + beta B) $^{238}_{92}\text{U} \rightarrow$ **$^{234}_{90}\text{Th}$** + alpha
 C) $^{210}_{83}\text{Bi} \rightarrow$ **$^{206}_{81}\text{Tl}$** + alpha D) $^{35}_{16}\text{S} \rightarrow$ **$^{35}_{17}\text{Cl}$** + beta

Half-life Practice Problems

1. Sodium-24 has a half-life of 15 hours. How much sodium-24 will remain in an 18.0 g sample after 60 hours?

18g 9g 4.5g 2.25g 1.125g
 0 1 2 3 4
 0h 15h 30h 45h 60h

2. After 42 days a 2.0 g sample of phosphorus-32 contains only 0.25 g of the Isotope. What Is the half-life of phosphorus-32?

2.0g 1.0g .5g .25g
 0 1 2 3
 42days

$$42 / 3 = 14 \text{ days} = \text{half-life}$$

3. Polonium-214 has a relatively short half-life of 164.seconds. How many seconds would it take for 8.0 g of this Isotope to decay to 0.25 g ?

8g 4g 2g 1g .5g .25g
 0 164 328 492 656 820sec

4. How many days does it take for 16 g of palladium-103 to decay to 1.0 g? The half-life of palladium-103 is 17 days.

16 g → 8g → 4g → 2g → 1g
 Half-lives: 1 2 3 4
 17 34 51 68hrs

5. In 5.49 seconds, 1.20 g of argon-35 decay to leave only 0.15 g. What is the half-life of argon-35?

1.2g .6g .3g .15g
 0 1 2 3 5.49/3 = 1.83 sec = half-life

6. Iodine-131, used to diagnose and treat thyroid conditions, has half-life of 8 days. How many days does it take for the amount of iodine-131 in the sample to decrease from 80 g to 5 g?

80g 40g 20g 10g 5g
 0 1 2 3 4
 0d 8d 16d 24d 32d

Fission and Fusion

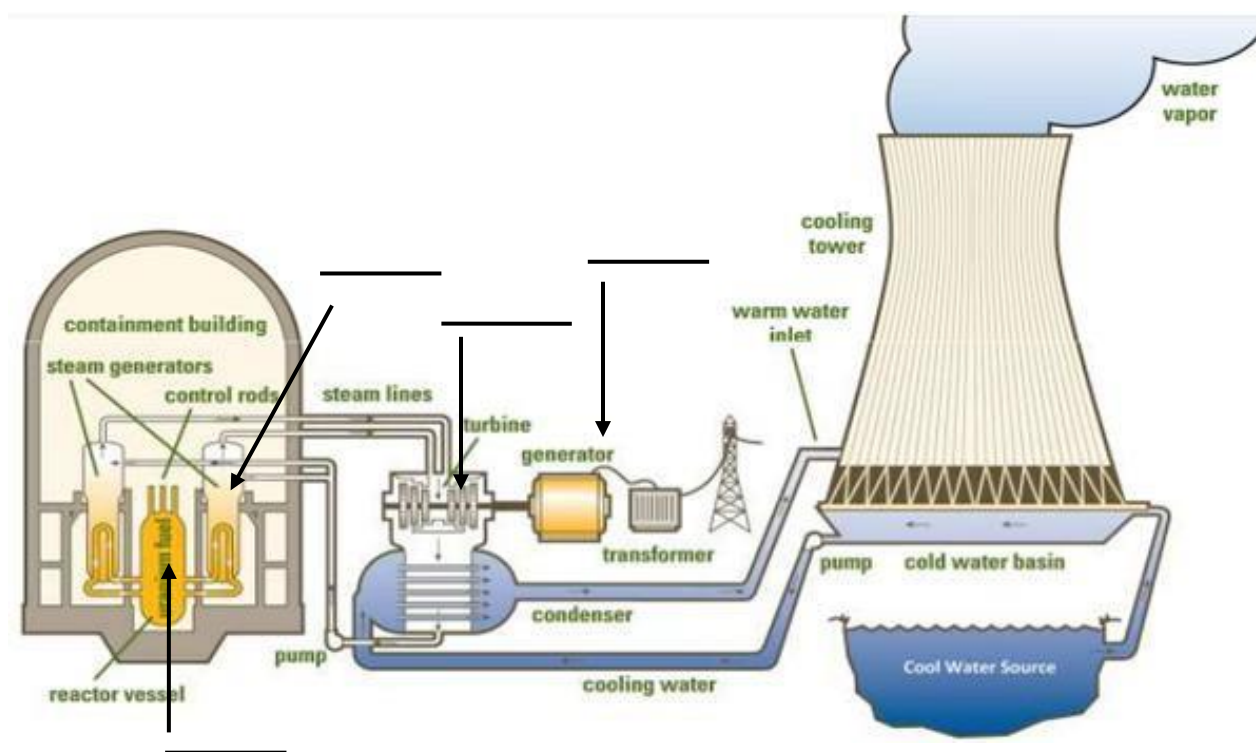
Nuclear:	Fission	Fusion
Occurs in Nuclear Power Plants	✓	
Occurs in the Sun / Stars		✓
Starts with Uranium-235	✓	
Starts with Helium Isotopes (Deuterium and Tritium)		✓
Results in a large release in energy	✓	✓
Releases 3 neutrons that start a chain reaction	✓	

1 large unstable atom breaks down into 2 smaller atoms	✓	
2 smaller atoms smash together to form 1 larger atom		✓
Product is a Helium atom		✓
Product is Barium and Krypton atoms	✓	

1. Explain how a nuclear power plant works in 4 basic steps.

- Reactor: fission reactions heat water
- Condenser: boiling water turns to steam
- Turbine: steam spins the turbine
- Generator: Spinning turbine changes the generator to power the city

2. On the picture below, identify which of the above steps (A, B, C, or D) belongs on each of the blank spaces.



3. How do we control the amount of fission occurring within the Reactor Core?

4.Fill the table below

Substance	Symbol	Atomic Number	Mass Number	Number of Protons	Number of Neutrons	Number of Electrons	Atomic Notation
Aluminum – 27	Al	13	27	13	14	14	$^{27}_{13}\text{Al}^-$
Iodine – 125	I	53	125	53	72	53	$^{125}_{53}\text{I}$
Phos-31	P	15	31	15	16	15	$^{31}_{15}\text{P}$
Argon-40	Ar	18	40	18	22	18	$^{40}_{18}\text{Ar}$
Potassium-39	K	19	39	19	20	19	$^{39}_{19}\text{K}$
Nickel-59	Ni	28	59	28	31	28	$^{59}_{28}\text{Ni}$
Beryllium-9	Be	4	9	4	5	4	^9_4Be
Magnesium – 26	Mg	12	26	12	14	12	$^{26}_{12}\text{Mg}$
Argon-42		18	42	18	24	18	$^{42}_{18}\text{Ar}$