Unit 2: The Atom and Nuclear Chemistry Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Block: \_\_\_\_\_

|  |
| --- |
| **Learning Targets** |
| 1. I CAN state the three main subatomic particles, their locations, charges, and “jobs” within the atom |
| 1. I CAN identify and describe an ion, isotope, and neutral atom |
| 1. I CAN calculate the atomic number and mass number for a given atom and write the isotopic notation |
| 1. I CAN calculate the number of each subatomic particle for a particular atom |
| 1. I CAN describe the characteristics of radioactive materials |
| 1. I CAN define fission and fusion, and describe the differences between the two types of nuclear reactions |
| 1. I CAN describe the use of the equation E=mc2 with respect to nuclear reactions |
| 1. I CAN identify the types of nuclear decay (alpha, beta, gamma) |
| 1. I CAN describe the basic concepts behind nuclear reactors and discuss the differences of nuclear bombs and reactors |
| 1. I CAN describe the basic concepts of half-life. |
| 1. I CAN describe the use of nuclear materials in medicine |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Chemistry Important Dates! | | | | | | |
| Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
| January 30 | 31 | 30 | February 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |

**Notes on Atomic Structure**

**Atomic Eggs**

**Part 1: Without opening the bag, “crack” your atomic egg. Under no circumstances should the particles be taken out of the bag!**

Given that the blue beads represent neutrons, answer the following:

1. How many neutrons do you have? \_\_\_\_\_\_\_\_\_\_\_
2. How many yellow beads do you have? \_\_\_\_\_\_\_\_\_\_
3. What do the yellow beads represent? \_\_\_\_\_\_\_\_\_\_ Explain your answer:
4. What is the atomic number of your element? Explain your answer:



1. What element do you have? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   1. How do you know this? Explain your answer:
2. What is the mass number of your atom? \_\_\_\_\_\_\_\_\_\_
3. How many pink beads do you have? \_\_\_\_\_\_\_\_\_\_
4. What do the pink beads represent? \_\_\_\_\_\_\_\_\_\_\_ Explain your answer:

**Part 2: Gather all the other students who have the same element you do. As a group, answer the following questions:**

1. Compare the number of protons and neutrons in your atomic egg. Is everyone’s exactly the same? \_\_\_\_\_\_\_\_\_\_\_
2. Is any factor the same for everyone in your group? \_\_\_\_\_\_\_\_\_\_\_
   1. If yes, what? \_\_\_\_\_\_\_\_\_\_\_
3. Does anybody’s differ in any way? \_\_\_\_\_\_\_\_\_\_\_
   1. If yes, what?
4. Given your answers to #10 and 11, define *isotope*:
5. How many isotopes does you group have represented? \_\_\_\_\_\_\_\_\_\_\_
6. What are the mass numbers of the isotopes you have represented?
7. Write a fraction representing how many in your group have data exactly like yours. \_\_\_\_\_\_\_\_\_\_\_
   1. Write this as a percentage (the proper word for this is *percent abundance* of your isotope) \_\_\_\_\_\_\_\_\_\_\_
8. Protons and neutrons (along with electrons) are all examples of what? \_\_\_\_\_\_\_\_\_\_\_
9. What part of the atoms did the egg shell represent? \_\_\_\_\_\_\_\_\_\_\_
   1. Explain the primary problem with using an egg shell to represent this part:

# Practice with Atomic Structure

The table below contains information about several elements. In each case, enough information has been provided for you to fill in the blanks. **Assume all atoms are neutral.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Isotope Name** | **Isotopic Symbol** | **Atomic Number** | **Mass Number** | **# of  Protons** | **# of Electrons** | **# of Neutrons** |
| 1. calcium-40 |  | 20 | 40 | 20 | 20 | 20 |
|  |  | 12 | 24 |  |  |  |
|  |  |  |  | 1 |  | 2 |
|  |  |  | 197 |  |  |  |
|  |  |  | 56 |  | 26 | 30 |
|  |  |  | 201 | 80 |  |  |
|  |  | 17 |  |  |  | 18 |

1. What two particles, when added together, represent the Mass Number? \_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_
2. What is the Atomic Number equal to? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

10. If an atom is neutral, then what must be true? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

11. What does the number represent in the Isotopes Name? (Ex. Calcium-40) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

12. Can the Atomic Number be found on the periodic table? If so where? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

13. Can the Atomic Mass be found on the periodic table? If so, where? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

14. Can the Mass Number be found on the periodic table? If so, where? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

15. Which particles are found in the nucleus? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Practice with Protons, Neutrons and Electrons

# Instructions: Complete the chart. Remember that the mass number is NOT found on your periodic table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Isotopic Symbol** | **Isotope**  **Name** | **Atomic #** | **Mass #** | **# of Protons** | **# of Neutrons** | **# of Electrons** |
|  | Rubidium-88 | 37 | 88 | 37 | 51 | 37 |
|  |  | 83 | 209 |  |  | 83 |
|  |  | 47 |  |  | 60 | 47 |
|  | Carbon-12 |  |  |  |  |  |
|  | Carbon 14 |  |  |  |  |  |
|  |  | 54 |  |  | 79 | 54 |
|  |  |  |  |  |  |  |
|  |  | 38 | 88 |  |  | 38 |

**Notes on Isotopes \*Draw examples of the Lemona and of Carbon Isotopes**

**Isotopes Practice**

1. What is an isotope? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. What does the number next to isotopes signify? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. How can you tell isotopes apart? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

For each of the following isotopes, write the number of protons, neutrons, and electrons.

|  |  |  |
| --- | --- | --- |
|  | Chromium-58 | Chromium-63 |
| # of protons |  |  |
| # of neutrons |  |  |
| # of electrons |  |  |

|  |  |  |
| --- | --- | --- |
|  | Nitrogen-15 | Nitrogen-14 |
| # of protons |  |  |
| # of neutrons |  |  |
| # of electrons |  |  |

|  |  |  |
| --- | --- | --- |
|  | -111 | -116 |
| # of protons |  |  |
| # of neutrons |  |  |
| # of electrons | 48 |  |

|  |  |  |
| --- | --- | --- |
|  | Carbon-12 | Carbon-14 |
| # of protons |  |  |
| # of neutrons |  |  |
| # of electrons |  |  |

|  |  |  |
| --- | --- | --- |
|  |  |  |
| # of protons | 22 |  |
| # of neutrons | 28 | 25 |
| # of electrons |  |  |

|  |  |  |
| --- | --- | --- |
|  |  |  |
| # of protons | 32 |  |
| # of neutrons | 38 | 41 |
| # of electrons |  |  |

**Notes on Nuclear Power Plant \*Include a labeled drawing of a Power Plant**

**Notes on Fission \*Draw a diagram Notes on Fusion \*Draw a diagram**

**Nuclear Introduction WebQuest**

Directions: Open Google Chrome and input the website [www.whatisnuclear.com](http://www.whatisnuclear.com). When the website opens, read through the paragraphs on the left side of the page.   
  
1) What is Fission? What does it release?  
  
2) The nuclear energy can be converted into several different things. What are three examples?   
  
3) Today, nuclear power plants can produce enough electricity to power \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.   
  
4) Complete the following chart of problems and solutions with Nuclear Energy

|  |  |
| --- | --- |
| **Problem** | **Solution** |
|  |  |
|  |  |
|  |  |

**Scroll back to the top menu and click “Learn About” and then “Radiation”**5) What is radiation?   
  
6) Why is the energy carried by radiation considered dangerous?

7) List and explains the three types of nuclear radiation. (You’ll explore more about them later)

8) Summarize how smoke detectors use radiation.  
  
  
9) What is an astonishing fact about Coal-burning plants compared to Nuclear plants?

10) What are some sources of naturally occurring radiation?

**Fission and Fusion Exploration**

**Directions**: Perform a Google search on “Phet Nuclear Fission”. Click on the first link and then click the green “Run Now” icon. Wait for the applet to load and then continue with the questions below.

1) What atom is the “fuel” for our experiment?

2) What is meant by the number 235? Is this the most common form of this element? Explain:

3) When you fire the gun, what type of particle does it release?

4) If the gun fires and “hits” the nucleus, describe what happens to the atom itself?

5) What is released when the atom decays? (Be specific – there are 3 different things!)

6) Imagine what might happen if there was more than one atom in the simulation. Describe your hypothesis below:

7) Switch the tab at the top of the page to “Chain Reaction.” Add 50 atoms of Uranium-235 and fire the gun towards one of the atoms. Sketch a diagram that represents a nuclear fission chain reaction:

8) Reset the nuclei and add only Uranium-238. Direct the gun at the new atom and fire. What happened to the mass number? What happened to the neutron?

9) Your lab partner says all atoms are fissionable. What is your educated response to them? (Complete sentence!)

10) On the Control Section click “Containment Vessel” Click and drag the grey handle so that it surrounds the gun. Add 75 atoms of Uranium-235 and fire a neutron. What happens when you have uncontrolled fission reactions?

12) Switch to the “Nuclear Reactor” Tab. This simulation shows what is happening in the core of a nuclear power plant. For the first trial, do not adjust the control rods. Fire a neutron and observe what happens. Reset the simulation and repeat for several trails. Discuss the length of time, the energy produced, and the location (does it spread out) for when the control rods are in place.

13) Press the “Reset Nuclei” button and drag the control rod adjuster to the bottom removing them from the reactor core. Press the “Fire Neutrons” button and record observations. Discuss the length of time, the energy produced, and the location(does it spread out) for when the control rods removed.

14) What do you think the purpose of the control rods are in a nuclear reactor? What problems might arise if there were a problem with the control rods?   
  
  
**Nuclear Fusion: In Google type “What is Fusion”. Click the first link  
http://fusioned.gat.com/what\_is\_fusion.html**1. Where do we see fusion energy every day?

2. What are the elements involved in nuclear fusion?   
  
  
3. What are the specific isotopes used for nuclear fusion?

4. What is required for fusion to take place?

5. Why do scientist care about fusion energy? (List 2 benefits)  
  
  
6. What makes achieving fusion on Earth difficult to achieve?

Based on information gained today, put a check mark in the column for the appropriate type of energy.

|  |  |  |
| --- | --- | --- |
|  | **Nuclear Fission** | **Nuclear Fusion** |
| Currently used in Nuclear Power Plants |  |  |
| Gives off the most energy |  |  |
| Fuel is isotopes of Hydrogen |  |  |
| Involves a Chain Reaction |  |  |
| Found in the sun and stars |  |  |
| Splitting of a large nucleus |  |  |
| The type of reaction for the 1st atomic bomb |  |  |
| Fuel is large atoms like Uranium or Plutonium |  |  |
| Associated with Plasma (state of matter) |  |  |

**Radioactivity Notes: Google Search for “Types of Radioactivity”** <http://www.darvill.clara.net/nucrad/types.htm>

1. What is the nucleus comprised of?

2. Some atoms are unstable, what will they do to become stable?

3. Nuclear decay is spontaneous. What does that mean?

4. What are the three ways that an unstable atom can become stable? (Include their symbols)

5. Draw and label an illustration of an **alpha** particle: 6. What is an alpha particle made up of?

7. Write the Isotopic notation for an alpha particle:

8. Describe the speed of alpha particles and what can stop them?

9. Draw and label an illustration of a **beta** particle: 10. What is a beta particle made up of?

11. Write the Isotopic notation for a beta particle:

12. Describe the speed of beta particles and what can stop them.

13. Draw and label an illustration of a **gamma** ray: 14. What are gamma rays made up of?

15. Write the Isotopic notation for a gamma ray

16. Describe what it takes to stop a gamma ray.

17. Order the types of decay from highest energy to lowest energy:

18. List the types of decay according to their mass from heaviest to lightest:

**Practice with Nuclear Equations**

**Write the isotopic notation for an Alpha Particle: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Beta Particle: \_\_\_\_\_\_\_\_\_\_\_\_**

1. Write a nuclear equation for the alpha decay of
2. Write the nuclear equation for the beta decay
3. Write the nuclear equation for the alpha decay of
4. Write the nuclear equation for the beta decay of
5. Write the nuclear equation for the alpha decay of
6. Write the nuclear equation for the beta decay of
7. Write the nuclear equation for the alpha decay of
8. Write the nuclear equation for the beta decay of
9. Write the nuclear equation for undergoing the following sequence: alpha, alpha, beta, beta, alpha, beta, alpha.

**Notes on Half Life**

**Half-Life Practice**

1. The half-life of a radioactive substance is 35.7 years. How much of a 1.00 kg sample of the substance will remain after 142.8 years?
2. A 96 g sample of a radioactive substance is left undisturbed for 21.0 hours. After this time, only 3.0 g remains. What is the half-life of the substance?
3. Germanium-69 has a half-life of 36.0 hours. If a sample that has been stored for 180.0 hours contains 84.8 g of germanium-69, what was the mass of the sample when it was originally stored?
4. Hydrogen-3 has a half-life of 12.3 years. How many years will it take for 88 g of it to decay to an 11 g sample?
5. 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?
6. Iodine-131 is used for diagnosing and treating thyroid gland malfunction. How much of a 4.80 g sample of iodine-131 remains after 32 days if its half-life is 8 days?

**Unit 2 Review: Atomic Structure and Nuclear Chemistry**

1. List the locations for each of the subatomic particles:
2. List the charges associated with each subatomic particle.
3. **Atomic Number:** Where is it found? What does this number represent?
4. **Average Atomic Mass:** Where is it found? What does this number represent?
5. **Mass Number:** What does this number represent?

Consider an atom based on the following notation:

1. The top number represents: The bottom number represents:

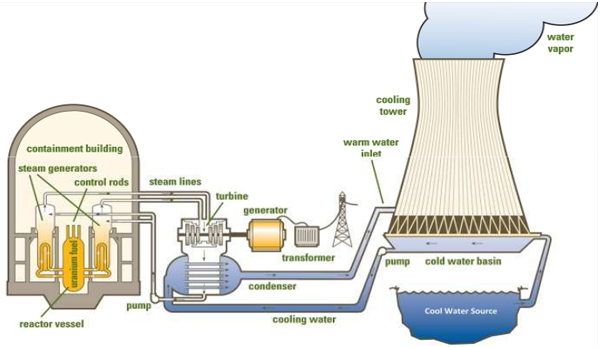
1. # of Protons? \_\_\_\_\_\_\_\_\_ # of Neutrons? \_\_\_\_\_\_\_\_\_\_ # of Electrons? \_\_\_\_\_\_\_\_\_
2. Is this atom the most common form of Fluorine? Explain why or why not:
3. Forms of the same element that have different numbers of neutrons are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
4. Explain what is happening in a chain reaction. What type of nuclear reaction is associated with chain reactions?
5. Explain what happens during a fusion reaction. Where do fusion reactions take place?
6. Which type of nuclear reaction produces the most energy?
7. List three examples of where the types of nuclear decay are used in helpful ways. (Not fission/fusion)
8. What does the term radioactive mean? Do atoms stay radioactive forever?
9. What are two types of background radiation?
10. Give a thorough description of an alpha particle:
11. Give a thorough description of a beta particle:
12. Give a thorough description of a gamma wave:
13. Write the equation for the alpha decay for these two elements:

A) 20984Po 🡪 B) 16868Er 🡪

1. Write the equation for the beta decay for these two elements:

A) 146C 🡪 B) 8035 Br 🡪

1. A radioactive isotope undergoes its half life every 2.0 seconds. What percentage of the original radioactive atoms will remain after 8.0 seconds?
2. How many half life cycles would be required for a 860.0 gram sample of radioactive thorium to decay until less than 10.0 grams remain?
3. What is an example of an uncontrolled nuclear reaction?
4. What is an example of a controlled nuclear reaction?
5. Using the picture below, identify what happens at A, B, C, and D.



**D**

**B**

**C**

**A**

A: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

C: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

D: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. How do we control the amount of fission occurring within the Reactor Core?
2. What is being released from the top of the “smoke stack”? Is that material dangerous at all?
3. Why are the Fuel Rods still dangerous even after we have done all the fission and all we have is Kr and Ba?
4. What does each variable in E=mc2 stand for?
5. What does the equation E=mc2 describe?