

Answer the following questions in your composition books.

- Would you expect two electrons to attract or repel each other?
Electrons all have a negative charge. Since 'like' charge repel, the two electrons will repel each other.
- What is the charge, positive or negative, of the nucleus of every atom?
Every atom has a positively charged nucleus because all atoms have a nucleus.
- Why is an atom electrically neutral?
Electrons and protons have EQUAL, but OPPOSITE charge despite the large difference in masses.
- What does the atomic number of each atom represent?
Tell how many protons are in the nucleus.
- What is the difference between the mass number and the atomic number of an atom?
The atomic number tells the number of protons in an atom's nucleus. The mass number is the sum of the total protons and neutrons in the atom's nucleus.

6. Complete the following table

Atomic #	Mass #	Number of protons	Number of neutrons	Number of electrons	Symbol of element
26	56	26	30	26	Fe
3	7	3	4	3	Li
19	41	19	22	19	K
92	235	92	143	92	U

- Name two ways that isotopes of an element differ.
- Different mass numbers
- Different number of neutrons in the nucleus

8. Calculate the atomic mass of silicon given the following data:

Isotope	Mass (amu)	Abundance (%)
Si-28	27.97692653	92.22
Si-29	28.97649472	4.69
Si-30	29.97377022	3.09

$$\begin{aligned} \text{Si-28: } & (27.97692653 \text{ amu}) \times (0.9222) = 25.80 \text{ amu} \\ \text{Si-29: } & (28.97649472 \text{ amu}) \times (0.0469) = 1.36 \text{ amu} \\ \text{Si-30: } & (29.97377022 \text{ amu}) \times (0.0309) = 0.926 \text{ amu} \end{aligned}$$

- Boron has two naturally occurring isotopes, B-10 and B-11. Given that boron has an atomic mass of 10.81, determine the percent abundance of each isotope if B-10 has a mass of 10.012 amu and B-11 has a mass of 11.009 amu.

Let x = fraction of B-10; Let $1-x$ = fraction of B-11

$$10.81 = (10.012)x + (11.009)(1-x) \rightarrow 10.81 = 10.012x + 11.009 - 11.009x$$

$$\rightarrow 10.81 = 0.997x + 11.009 \rightarrow -0.199 = -0.997 \rightarrow x = 0.200$$

$$1-x = 0.800$$

10. Answer the following short answer questions:

- Copper has two major isotopes: Cu-63 and Cu-65. Find the atomic mass on your periodic table and explain which isotope of copper is most abundant in nature. Copper = 63.546

which is closer to Cu-63. which makes Cu-63

most abundant in nature.

- Define 'amu' and describe its meaning.

Amu = Atomic Mass Unit. Amu is based on a single atom of the isotope, carbon-12. 1 amu = 1/12 the of a single C-12 atom. Or, an atom of C-12 has a mass of exactly 12 amu.

c. Rutherford's atomic theory proposed a dense nucleus surrounded by very small electrons. This implies that atoms are composed mainly of empty space. If all matter is mainly empty space, why is it impossible to walk through walls or pass your hand through your desk?

Strong forces that exist between nuclei that extend beyond the boundary of the atom. These repulsive forces make it impossible for that many atoms to pass through a similar number of atoms.

d. Describe the experiment that led Rutherford to propose his model of the atom. What observations led to his conclusions (atom is mostly empty space surrounding a very small, positively charged nucleus)?
 Gold Foil was hit with alpha particles, most went straight through, but some came back at different angles. Determined that atoms are mostly empty space with a central nucleus object.

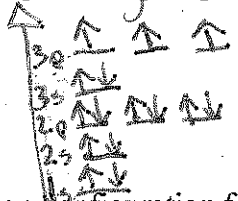
11. What does the principle quantum number, n, represent?
 The energy level that an electron is occupying. n = 1, 2, 3, ...

12. List all the possible subshells (or sublevels) in the following energy levels: n=1, n=2, n=3, n=4?
 n=1: 1s
 n=2: 2s 2p
 n=3: 3s 3p 3d
 n=4: 4s 4p 4d 4f

13. What is the maximum number of electrons that may fit in the following energy levels: n=1, n=2, n=3, n=4?
 n=1: 2 electrons; n=2: 8 electrons; n=3: 18 electrons; n=4: 32 electrons

14. Define the following: Aufbau Principle, Pauli Exclusion Principle, Hund's Rule
 Aufbau: Electron orbitals are filled on the lowest energies to highest.
 Pauli: Not two electrons in an atom may have the identical set of quantum characteristics.
 Hund's: when electron orbitals are filled partially fill a sublevel with one electron before pairing electrons in the same orbital. Unpaired = parallel spin.

15. Draw the orbital energy diagram for phosphorus, illustrating all electrons in their ground state.



16. a) Write the full electron configuration for sulfur. S: 1s² 2s² 2p⁶ 3s² 3p⁴
 b) Underline the subshells that constitute the valence electron shell for sulfur.

(3s² 3p⁴)

17. Copper has an electron configuration of 1s²2s²2p⁶3s²3p⁶3d¹⁰4s¹. Is this expected? No. If not, explain why the electron configuration is different from what you would expect.

It violates the Aufbau principle by not filling the 4s subshell before the 3d subshell. It is more stable to have d-sublevels filled rather than unfilled.

18. An element has an electron configuration of [Ne]3s²3p². What element is this?

Silicon

19. An element has 2 electrons in its 5s subshell and 3 electrons in its 4d subshell. What element is it?

Ni (Niobium)

20. What is unique about the electron configurations of the Noble Gases?
 The Noble Gases all have valence electron configuration of s²p⁶, which makes their outer electron shells full.

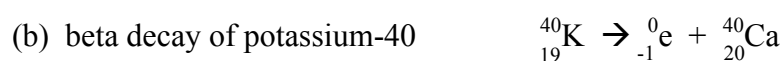
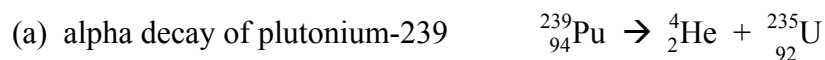
21. What trends are observed in atomic radius, ionization energy, and electronegativity of the elements as you go across a period (left to right)? Explain why we observe these trends.
 R ↓ IE ↑ EN ↑ Nuclear charge increases due to increased number of protons and causes radius to decrease.

22. What trends are observed in atomic radius, ionization energy, and electronegativity of the elements as you go down a group? Explain why we observe these trends.
 R ↑ IE ↓ EN ↓ more shielding due to more electrons to block nuclear charge causes radius to increase.

12. Complete the blanks in the following table.

Radiation	Symbol	Charge	Mass (amu)	Best shielding	Internal Health Risk (low, moderate, or high)	External Health Risk (low, moderate, or high)
Alpha	${}^4_2\alpha$ or ${}^4_2\text{He}$	+2	1	Paper, clothing	High	Low
Beta	${}^0_{-1}\beta$ or ${}^0_{-1}e$	-1	0.00054	Sheet metal, 1 meter of dry air, wood	High	Moderate (can cause skin burns and permanent damage to eyes)
Gamma	${}^0_0\gamma$	None	None	Lead or other very dense metal	High	High

13. Write a balanced nuclear equations for the following types of radioactive decay:



14. What is a transuranium element? Describe the unique features of transuranium elements.
Transuranium elements are all elements with atomic numbers greater than 92. All isotopes of these elements are radioactive, and are synthetically made
15. Describe the difference between fission and fusion. What is a chain reaction? **Fission is the splitting of a heavy, unstable nucleus into two or more smaller atoms. Large amounts of energy and more neutrons are released when the atom splits. A chain reaction is possible because each time an atom splits, more neutrons are produced, and those neutrons can go on to cause more fission.**

Fusion is the combining of two small atoms to produce a larger atom. Fusion is the process by which stars produce energy.

The first atomic bombs utilized fission only, but modern day thermonuclear devices (hydrogen bomb) utilize both fission and fusion. The energy from the fission is used to fuse smaller atoms together.

Nuclear reactors used for power generation utilize the fission process. Experimental reactors utilizing fusion exist, but do not produce practical amounts of energy, because the reactants are very hard to control due to the extremely high temperatures required to force two nuclei together.