

The modern atomic model has been developed using experimental evidence. Atomic theories describe the behavior of atoms as well as energy changes in the atom. Energy changes in an isolated atom occur only in discrete jumps. Change in structure and composition of the nucleus result in the conversion of matter into energy.

STANDARD II: Students will understand the relationship between energy changes in the atom specific to the movement of electrons between energy levels in an atom resulting in the emission or absorption of quantum energy. They will also understand that the emission of high-energy particles results from nuclear changes and that matter can be converted to energy during nuclear reactions.

Objective 1 Evaluate quantum energy changes in the atom in terms of the energy contained in light emissions.

1. What is an “energy level”?

Light (photons) are involved whenever an electron changes energy levels. Light is absorbed when _____. Light is emitted when _____.

The energy level of an atom is a measure of the relative amount of energy absorbed by electron waves. Energy is absorbed or released by electron waves in the form of photons or quanta (small packets of energy). Light is absorbed as electrons increase in energy. Light is emitted when electrons decrease in energy.

2. What do we call the little “packets” of energy that our universe is made out of? (The smallest measurable amount of energy that make everything else.) **Small measures of energy are described as quanta.**
3. The bigger a wavelength is, the **_less_** energy it has. We say that wavelength and energy are **_inversely_** proportional.
4. The higher the frequency is, the **_more_** energy it has. We say that frequency and energy are **_directly_** proportional.
5. If an electron makes a really BIG jump up in energy levels, it means that a **_lot_** (lot/little bit) of energy was needed. What color of light was probably absorbed? **_violet_** If an electron makes a really SMALL jump down in energy levels, it means that a **_little bit_** (lot/little bit) of energy was released. What color of light will we see if we are standing nearby? **_red_**
6. Each element emits/absorbs only very specific colors of light. (Remember earlier in the year when we burned different chemicals and saw very different colors.) Why does this happen? How does this support the theory that electrons can only occur in allowed energy levels? **As electrons absorb light energy, electron waves expand out to higher energy orbitals. Each element has a different number of electrons, and each element’s ground state of electrons is different, so every element will have its own unique electron movement between energy levels as energy is absorbed. With every jump in energy level, a specific frequency of light is absorbed, as electrons fall back to original energy levels the same frequency of light is released.**

7. What is a bright line emission spectrum? How can we use them to identify unknown elements? When the light emitted by a specific element is passed through a prism, its emission spectra is observed. Since the electrons moving between energy levels are unique for each element, the spectra is different for every element and can be used to identify unknown elements.

Objective 2 Evaluate how changes in the nucleus of an atom result in emission of radioactivity.

8. When changes occur in the nucleus of an atom, we call it a **nuclear** reaction. It changes the identity of the atom. (You actually can turn lead into gold!) Nuclear reactions involve a LOT **more** energy than regular chemical reactions.
9. What are the three kinds of radioactive radiation. Say what they are made of, how much energy they have, and how we can stop them.
Alpha particles – released when nucleus is too big, same as a helium nucleus, high energy with high mass, can be stopped with paper.
Beta particles – released when there are too many neutrons in the nucleus to create a new proton, same as an electron, high energy low mass, can be stopped with metallic foils.
Gamma radiation – released anytime there is a change in the nucleus, high energy, no mass, pure photons, not fully stopped with thick concrete or thick lead.

10. What is a half-life?

Time needed for one half of a radioactive sample to decay.

11. Use the following table to determine the half-life of element Bob. After eight days, how much of Bob will be left? (use a calculator)

Mass	10g		5g		2.5g		1.25g		.625g		
Days	0	1	2	3	4	5	6	7	8	9	10

Half-life of the sample is two days. After 8 days .625 grams will remain.

12. What do we call the force that holds the nucleus together? What particles are held together in the nucleus? When the bonds of the nucleus are broken, how does that compare to the breaking of chemical bonds?

Strong nuclear force holds the nucleus together. Protons and neutrons are held together. The energy released in breaking bonds of the nucleus release much greater amounts of energy than when chemical bonds break.

13. Where does all the energy in nuclear reactions come from?

With nuclear changes, mass is converted to energy. The difference in the mass of a nuclei and the combined mass of individual protons and neutrons that make up the nucleus is called the mass defect. This loss of mass is converted into energy. $E=mc^2$

14. What do we call it when two nucleuses join together? **Fusion**, the nuclei of elements smaller than iron may fuse to create more stable nuclei.

What do we call it when one nucleus splits apart? **Fission, the nuclei of elements larger than iron may divide to form more stable, smaller nuclei.**

15. Give two examples of how radiation is harmful.

Radiation strips atoms and molecules of electrons, changing chemical processes in the body. High energy radiation can cause burns, lesions, and other harmful effects.

16. Give two examples of how radiation is helpful.

High energy radiation can be used to kill harmful bacteria on food or tools increasing the time it takes for food to spoil, and preparing sterile surgical tools.

Harmless radioisotopes can be added to the bloodstream and detected as they travel through the body to create detailed images of internal organs which is used to diagnose potential problems.