**Tom the Atom, Books Series**

**Standards and Curriculum in the USA.**

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## **Introduction:**

Tom-the-Atom represents the Carbon Atom, the most crucial Atom in the Universe. Tom the Atom is a series of illustrated science books for children and adolescents (https://www.Tom-the-Atom.com). The young readers will become familiar with the world of Atoms, which makes up all the material in the Universe: the Earth, the planets, the stars, and you and me. At the same time, the readers will learn much about the Earth, the Solar System, and the Universe.

Books 1 to 21 will teach the young learners the necessary atoms, rules, and concepts to understand the behavior of the 94 existing natural atom types. At the same time, you will learn to read the atom characters by learning how to read their behaviors as in the periodic table.

From Books 1 to 9, Tom the Atom introduces several important concepts to understand how atoms are the building blocks of Nature and the entire Universe. Book 10 introduces the idea of electricity needed to understand the character of certain Atons’ families (metals). Book 11 introduces the concept of Earth and the Universe to understand better the concepts of solids and their most important secret, which tells you the solids' character: crystallinity. Books 12 to 16 introduce more critical representatives of the atom's families, their position in the Periodic Table, and their character. Book 17 is a Review of what you have learned so far. Books 18 to 21 introduce important concepts, rules, and definitions that help you quickly and easily guess the atom character when placed in that brilliant Periodic Table. Book 22 is again a review of some critical concepts you learned in Books 1 to 21.

You will learn atoms' rules, atoms' friends, and atom's foes!

Books 23 to 31 only discuss crystallinity, the most essential characteristic of solid materials (many molecules combined). They teach the reader how materials are distributed in the Universe and how they are expressed as solids, liquids, and gases for the entire Universe. If we talk about solid characteristics, we need to understand Crystallinity!

Tom the Atom Books Series aims to teach the reader Sciences easily, combining important concepts with easy hands-on and mental experiments.

Teachers are aware that among the fifty states of the Union, there are about three central Standards/Curricula practiced in Middle School and High School: Those based on Framework (NRC), NGSS, and a variance of those two guidelines adopted by Florida and other six steals (NGS). Following herewith, we briefly describe each Book and how each Standard fits.

At the end of the summary of the books published, we give an Example of how to incorporate the material for each book into the Curriculum if the subject is being taught in Middle or high school.

This is followed by a historical development of the three types of existing standards implemented by the fifty states in the US.

## **Standard/Curricula per Book:**

**Tom the Atom, Book 1: Carbon Atom is my name; Tom the Atom is my nickname!**

Tom the Atom makes two friends on Earth, Henry and Mary. Tom invites them to visit his world, which comprises ten families of Atoms. Tom-the-Atom belongs to the Family of the Non-Metals. Henry and Mary are terrestrials from San Francisco, California, in the US.

## **Learning Objectives** (none-introduces the main Series character: Tom the Atom (Carbon Atom from the family of Non-Metals).

**Tom the Atom, Book 2: Atoms are like guys, with big eyes that look at you in surprise and have different round sizes!**

Tom-the-Atom explains to Henry, Mary, and you how Atom's bodies are made and how they get their weight, size, and characteristics. Atoms are made of a nucleus or belly with two main types of small particles (protons (positive charge), neutrons (no charge)) and layers (orbitals) surrounding their belly in which tiny electrons (negative charges) circulate the nucleus.

## Learning Objectives (New Concepts: Describe the general way atoms are formed)

Frameworkfor K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ The book's focus on the structure of atoms, including protons, neutrons, and electrons, aligns with understanding the fundamental building blocks of matter.
* **PS1.B: Chemical Reactions**:
	+ The book discusses basic chemical reaction principles explaining how atoms interact and bond.

##### **Crosscutting Concepts:**

* **Patterns**:
	+ Recognizing patterns in the arrangement and behavior of subatomic particles.
* **Scale, Proportion, and Quantity**:
	+ Understanding the scale of atomic structures and subatomic particles' relative sizes and charges.

NGSSNext Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The book’s explanation of atomic structure supports this performance expectation.
* **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
	+ Understanding atomic structures is foundational for comprehending how materials are synthesized from elements.
* **HS-PS1-1**: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level.
	+ Understanding the basic structure of atoms is foundational for predicting element properties.

NGSSSNext Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.6**: Recognize that elements are grouped in the periodic table according to the similarities of their properties.
	+ The book's discussion on atoms and their components aligns with this standard.
* **SC.8.P.8.7**: Recognize that elements are grouped in the periodic table according to the similarities of their properties.
	+ The book’s focus on atomic structure helps students understand how elements are categorized.
* **SC.912.P.8.4**: Explore the scientific theory of atoms (also known as the atomic theory) by describing the structure of atoms in terms of protons, neutrons, and electrons and differentiating among these particles in terms of their mass, electrical charges, and locations within the atom.
	+ The content of the book directly addresses this standard.

Application in Curriculum

* **Middle School Science Curriculum**: Teachers can use Book 2 to introduce and reinforce fundamental concepts related to atomic structure. It can be integrated into lessons on physical science and chemistry.
* **High School Science Curriculum**: The book can serve as a supplementary resource to deepen students' understanding of atomic theory and the properties of subatomic particles.

**Tom the Atom, Book 3: Bonds make a world fond!**

Tom the Carbon explains how the 92 Atoms combine with their twins (tuples) or other atoms' twins to form molecules. Molecules form materials and everything you observe around you. Atoms do so by using only the electrons of their outermost shell. Those electrons, and only those, are called Valence electrons. By "handshaking" those electrons with other atoms' outer electrons, atoms form Bonds. Depending on the number of handshakes is the type of material they create. For example, when Tom combines among themselves (other tuples of Carbon), it can exist as a shiny diamond material--when using four handshakes per Atom—or as a piece of soft, opaque graphite material––when using three handshakes!

## Learning Objectives (New Concepts: The students will be able to understand what a molecule is. The reader will understand how atoms join other atoms to form molecules and draw atoms covalent bonds to form molecules)

Frameworkfor K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ The book's focus on the structure of atoms and how they form bonds to create different materials aligns with understanding the fundamental building blocks of matter.
* **PS1.B: Chemical Reactions**:
	+ The book addresses the basic principles underlying chemical reactions by explaining how atoms interact and bond to form molecules.

##### **Crosscutting Concepts:**

* **Patterns**:
	+ Recognizing patterns in the arrangement of atoms and the types of bonds they form.
* **Structure and Function**:
	+ Understanding how the structure of atoms and their bonding behavior determines the properties of the resulting materials.

NGSS Next Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The book’s explanation of atomic structure and bonding supports this performance expectation.
* **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
	+ Understanding atomic bonds and how they form various materials aligns with this performance expectation.
* **HS-PS1-2**: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
	+ The book’s focus on valence electrons and bonding directly supports this high school performance expectation.

NGSSS Next Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.7**: Interpret formula representations of molecules and compounds regarding composition and structure.
	+ The book's discussion on how atoms bond to form molecules fits this standard.
* **SC.912.P.8.7**: Interpret formula representations of molecules and compounds in terms of composition and structure.
	+ The focus on atomic bonding and the formation of materials aligns with this standard for high school students.

Application in Curriculum

* **Middle School Science Curriculum**: Teachers can use Book 3 to introduce and reinforce concepts related to atomic structure, valence electrons, and bonding. It can be integrated into lessons on physical science and chemistry.
* **High School Science Curriculum**: The book can serve as a supplementary resource to deepen students' understanding of atomic theory, chemical bonding, and the properties of materials.

**Tom the Atom, Book 4: Water Matters!**

Tom the Atom introduces you to two additional siblings from his same Family of Non-Metals: a tiny Hydrogen atom and a giant Oxygen atom. When two hydrogen atoms and one oxygen atom make two firm handshakes with each other (covalent bonds), the three atoms produce a water molecule H-O-H or H2O). That is the water to quench your thirst, the most crucial molecule in the Universe.

## Learning Objectives (New Concepts: After this lesson, students will be able to Identify covalent bonds).

Frameworkfor K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ The book's focus on the atomic composition and bonding of water molecules aligns with understanding the fundamental building blocks of matter.
* **PS1.B: Chemical Reactions**:
	+ The book addresses the basic principles underlying chemical reactions by explaining how hydrogen and oxygen atoms form covalent bonds to create water molecules.

#### **Crosscutting Concepts:**

* **Patterns**:
	+ Recognizing patterns in the formation and arrangement of atoms in molecules.
* **Structure and Function**:
	+ Understanding how the structure of water molecules determines their properties and essential role in the Universe.

NGSS Next Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The book’s explanation of atomic structure and bonding in water molecules supports this performance expectation.
* **MS-PS1-4**: Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
	+ Understanding the composition and properties of water aligns with this performance expectation.
* **HS-PS1-2**: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
	+ The book’s focus on valence electrons and covalent bonding directly supports this high school performance expectation.

NGSSSNext Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.7**: Interpret formula representations of molecules and compounds regarding composition and structure.
	+ The book's discussion on water molecule formation fits this standard.
* **SC.912.P.8.7**: Interpret formula representations of molecules and compounds in terms of composition and structure.
	+ The focus on atomic bonding and the formation of water molecules aligns with this standard for high school students.

Application in Curriculum

* **Middle School Science Curriculum**: Teachers can use Book 4 to introduce and reinforce concepts related to atomic structure, valence electrons, and covalent bonding. It can be integrated into lessons on physical science and chemistry.
* **High School Science Curriculum**: The book can serve as a supplementary resource to deepen students' understanding of atomic theory, chemical bonding, and the properties of molecules like water.

**Tom-the-Atom, Book 5: We play with the concepts we learned on weekends!**

Mary, Henry and you review the concepts they have learned when visiting the World of Atoms. Henry and his friends examined the concepts of Carbon and covalent bonds, and Mary and her friend wanted to isolate a single water molecule.

## Learning Objectives (Review Books 1-4: After this lesson, students will be more confident in defining an atom structure, understand what a molecule is, how atoms join other atoms to form molecules, draw atoms' covalent bonds to form molecules)

Framework for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**: Reviewing atomic structure and bonding.
* **PS1.B: Chemical Reactions**: Understanding the formation of covalent bonds and the structure of molecules like water.

##### **Crosscutting Concepts**

* **Patterns**: Recognizing patterns in atomic bonding.
* **Structure and Function**: How molecular structure determines function and properties.

NGSS Next Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of molecules.
* **MS-PS1-3**: Describe synthetic materials and their impact.
* **HS-PS1-1**: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level.
	+ Understanding electronegativity and the behavior of Alkali Metals aligns with this performance expectation.
* **HS-PS1-2**: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
	+ Focusing on ions, electronegativity, and chemical bonding directly supports this high school performance expectation.

### NGSSS Next Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.7**: Recognize that elements are grouped in the periodic table according to the similarities of their properties.
	+ The book’s discussion on the periodic table and Alkali Metals aligns with this standard.
* **SC.912.P.8.4**: Describe the structure of atoms, including the formation of ions and electronegativity.
	+ The explanation of ionic formation, electronegativity, and Alkali Metals' properties fits this standard.

Application in Curriculum

###### **AP Chemistry**:

* **Unit 1: Atomic Structure and Properties**:
	+ Understanding the formation of ions and the periodic trends.
	+ Exploring the concept of electronegativity in atoms.
* **Unit 2: Molecular and Ionic Compound Structure and Properties**:
	+ Reviewing how ions form and bond to create compounds.

**High School Chemistry**:

* **Chapter on Atomic Structure and the Periodic Table**:
	+ Introducing students to the periodic trends, including electronegativity and the properties of elements in Group 1A.
* **The chapter on Chemical Bonding**:
	+ Explaining the formation of ions, their role in bonding, and electronegativity.

**Tom the Atom, Book 6: Lithium is highly reactive and flammable; do not eat it; it distracts you!**

Tom-the-Atom introduces the concept of the Periodic Table. Humans invented the Periodic Table to accommodate the 92 naturally occurring atoms in the Universe and their families. The readers will learn to guess each Atom's character by only looking at the Periodic Table. You will meet Lithium (nickname Li) from the Alkali Metals family. That is the first or more left Family in the Periodic Table. The elements or Atoms of that Family are recognized because they only have one single electron in their outermost orbital. They have a super active and aggressive personality.

## Learning Objectives (New Concepts: After this lesson, students will be able to Describe the nature of ions, the periodic table, the concept of electronegativity in atoms, And the characters of the Alkali Metals family).

Framework for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**: Understanding the periodic table and properties of alkali metals.
* **PS1.B: Chemical Reactions**: Discussing the reactivity of alkali metals and their bonding behavior.

##### **Crosscutting Concepts**

* **Patterns**: Recognizing trends in the periodic table.
* **Structure and Function**: Linking atomic structure to chemical properties.

### **NGSS** Next Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules.
* **HS-PS1-2**: Construct explanations based on electron states and periodic trends.

Application in Curriculum

**Middle School Science Curriculum**:

* **Book 6**: Introduce the Periodic Table and discuss the properties of alkali metals like lithium. It can be integrated into lessons on the periodic table and atomic properties.

**High School Science Curriculum**:

* **Book 6**: Provide a deeper understanding of the periodic table and periodic trends.

**Tom-the-Atom, book 7: Standing at my podium, I am trying to watch my Sodium!**

Tom-the-Atom calls on Sodium, Na, from the Alkali Metal Family in Column 1 of the Periodic Table. All atoms in Column 1 (Group 1A) have only one Valence electron in their outermost shell. Sodium is a brother of Lithium (same Family). Sodium, Na, is a soft, silvery-white, highly reactive metal. Sodium has a single electron in its outermost shell that readily donates. If Sodium (Na) loses that outermost negatively charged electron, it forms a positively charged atom named Na+ Cation or Sodium-ion. Sodium and Lithium have remarkably similar characters and characteristics. The concepts of "Positive" and "Negative" Ions and "Ionic Bonding" are introduced and reviewed.

## Learning Objectives (New Concepts: After this lesson, students will be able to Learn to use the periodic, Learn the difference between atom families and atoms' positions in the Periodic Table, and Learn of a brother of Lithium, Sodium introducing the concepts of positive and negative ions and ionic bonding)

Framework for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**: Exploring the properties of sodium and ionic bonding.
* **PS1.B: Chemical Reactions**: Understanding how sodium forms ions and participates in chemical reactions.

##### **Crosscutting Concepts**

* **Patterns**: Recognizing trends in the periodic table and bonding behavior.
* **Structure and Function**: Understanding how the structure of atoms like sodium influences their function and reactivity.

### NGSS Next Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The book’s explanation of atomic structure and bonding supports this performance expectation.
* **HS-PS1-1**: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level.
	+ Understanding electronegativity and the behavior of alkali metals aligns with this performance expectation.
* **HS-PS1-2**: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
	+ Focusing on ions, electronegativity, and chemical bonding directly supports this high school performance expectation.

### **NGSSS** Next Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.5**: Explore the scientific theory of atoms and the periodic table.
* **SC.8.P.8.7**: Recognize that elements are grouped in the periodic table according to the similarities of their properties.
	+ The book’s discussion on the periodic table and alkali metals aligns with this standard.
* **SC.912.P.8.4**: Describe the structure of atoms, including the formation of ions and the concept of electronegativity.
	+ The explanation of ionic formation, electronegativity, and alkali metals' properties fits this standard.
* **SC.912.P.8.7**: Describe the structure of atoms, including the formation of positive and negative ions.

Application in Curriculum

**AP Chemistry**:

* **Unit 1: Atomic Structure and Properties**:
	+ Understanding the formation of ions and the periodic trends.
	+ Exploring the concept of electronegativity in atoms.
* **Unit 2: Molecular and Ionic Compound Structure and Properties**:
	+ Reviewing how ions form and bond to create compounds.

**High School Chemistry**:

* **Chapter on Atomic Structure and the Periodic Table**:
	+ Introducing students to the periodic trends, including electronegativity and the properties of elements in Group 1A.
* **A chapter on Chemical Bonding**:
	+ Explaining the formation of ions, their role in bonding, and electronegativity.

**Middle School Science Curriculum**:

* **Book 7**: Explore the properties of sodium and introduce the concepts of ions and ionic bonding. It can be integrated into lessons on chemical bonding and reactivity.

**High School Science Curriculum**:

* **Book 7**: Enhance students' understanding of ionic bonding and the properties of alkali metals.

**Tom-the-Atom, Book 8: A cup of Calcium daily keeps your teeth and bones from breaking away!**

Tom-the-Atom introduces Calcium (Ca) and Magnesium (Mg) from the Alkaline Earth family in Column 2 of the Periodic Table. Atoms from Group 2A (Column 2) have only two valence electrons in their outermost shell. They prefer to lose those electrons and keep their inner shells full to be stable rather than hunting for six additional valence electrons and filling up their outermost shell with eight valence electrons. When they lose those two electrons, the atoms have a double positive charge (because they lost two negative electrons). They are called divalent positive ions (divalent cations).

## Learning Objectives (New Concepts: After this lesson, students will be able to Learn to use the periodic table to guess the Atoms' character and behaviors, faux, friends, and enemies. Learn about the Alkaline Earth Metals family)

Frameworkfor K-12 Science Education

* **PS1.A: Structure and Properties of Matter**: Understanding the properties of calcium and magnesium, their reactivity, and the formation of divalent cations.
* **PS1.B: Chemical Reactions**: Discussing how alkaline earth metals form compounds.

##### **Crosscutting Concepts**

* **Patterns**: Recognizing patterns in the periodic table and the behavior of Group 2 elements.
* **Structure and Function**: Understanding how the structure of alkaline earth metals affects their reactivity.

NGSSNext Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
* **HS-PS1-2**: Construct and revise explanations for the outcomes of simple chemical reactions based on electron states.

### **NGSSS** Next Generation Sunshine Science Standards (and six additional States)

* **SC.8.P.8.5**: Explore the scientific theory of atoms and the periodic table.
* **SC.912.P.8.7**: Describe the structure of atoms, including the formation of positive and negative ions.

Application in Curriculum

**AP Chemistry**:

* **Unit 1: Atomic Structure and Properties**:
	+ Understanding the formation of ions and the periodic trends.
	+ Exploring the concept of electronegativity in atoms.
* **Unit 2: Molecular and Ionic Compound Structure and Properties**:
	+ Reviewing how ions form and bond to create compounds.

**High School Chemistry**:

* **Chapter on Atomic Structure and the Periodic Table**:
	+ Introducing students to the periodic trends, including electronegativity and the properties of elements in Group 2A.
* **A chapter on Chemical Bonding**:
	+ Explaining the formation of ions, their role in bonding, and electronegativity.

**Middle School Science Curriculum**:

* Explore the properties of calcium and magnesium and introduce the concepts of ions and ionic bonding. It can be integrated into lessons on chemical bonding and reactivity.

**High School Science Curriculum**:

* Enhance students' understanding of ionic bonding and the properties of alkali metals.

**Tom the Atom, Book 9: Meet Iron the Lion!**

You will meet atoms in Group 3B (Columns 3 to 12 in the Periodic Table). To explain their character, Tom-the-Atom introduces the concept of shells or orbitals (**K**, **L**, **M**, **N**, **O**, **P**). Each shell has Sub-Shells (**s**, **d**, **p**, **f**). Tom calls a larger atom that belongs to the "Transition Metals" large Family, Iron, Fe. Tom-the-Atom explains how challenging it is to predict the characters of atoms in the large Group 3B. That is because their Nature depends on who they interact with.

## Learning Objectives (New Concepts: After this lesson, students will be able to understand the difference between shells and subshells in the atomic structure of the atoms, Introduce a member of the large group of Transition Metals, and get a glimpse of their capricious character and rules to combine with other atom Become familiar with the structure of the atom)

Framework for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**: Understanding the properties of transition metals, their electron configurations, and how these properties affect their reactivity.
* **PS1.B: Chemical Reactions**: Introducing the concept of transition metals and their complex behaviors in chemical reactions.

##### **Crosscutting Concepts**

* **Patterns**: Recognizing patterns in the periodic table and the behavior of transition metals.
* **Structure and Function**: Understanding how the structure of transition metals influences their properties.

NGSS Next Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
* **HS-PS1-1**: Use the periodic table as a model to predict the relative properties of elements based on patterns of electrons in the outermost energy level.

### **NGSSS** Next Generation Sunshine Science Standards (and six additional States)

* **SC.8.P.8.7**: Recognize the patterns and properties of elements in the periodic table.
* **SC.912.P.8.6**: Explore the periodic table and its organization.

Application in Curriculum

**Middle School Science Curriculum**:

* **Unit on Chemical Reactions and Properties of Matter**:
	+ Introducing students to the properties of noble gases and why they are non-reactive.
* **Unit on Periodic Table and Element Properties**:
	+ Understanding the placement of noble gases in the periodic table and their unique properties.
* **Focus**:
	+ This standard encourages students to identify and explain the patterns and properties of elements as arranged in the periodic table. It includes understanding trends such as atomic radii, ionization energy, and electronegativity.

**High School Chemistry**:

* **Chapter on Atomic Structure and the Periodic Table**:
	+ Introducing students to the properties of noble gases and their behavior.
* **A chapter on Chemical Bonding and Reactions**:
	+ Explaining why noble gases do not form chemical bonds due to their entire valence shell.
* **Chapter on Stability and Reactivity**:
	+ Exploring the concept of atomic stability and how it relates to the inertness of noble gases.

**Tom the Atom, Book 10: A Day at the Museum: Henry and his friends discover Electricity!**

Henry and his classmates visit an exhibit on "Electricity" at the Lawrence Hall of Science --in Berkeley, California. Children learn the concept of Electricity, a current of a metal's Valence electrons that are not firmly attached to the Atom's nuclei. In metallic atoms, the valence electrons are so loose that they can move from one Atom to another when the atoms are together, forming a piece of metal. When a voltage difference is applied to the metal, the electron moves freely, creating a current as a river. Electricity is the flux or flow of "free" electrons.

## Learning Objectives (Complemental Concept: After this lesson, students will be able to Explore the electric potential and examine the fundamentals of electricity)

FrameworkforK-12 Science Education

* **PS1.A: Structure and Properties of Matter**: Understanding the properties of metals and how their valence electrons contribute to electrical conductivity.
* **PS3.A: Definitions of Energy**: Exploring the concept of electrical energy and its flow through conductors.

##### **Crosscutting Concepts**

* **Energy and Matter**: Understanding the flow of electrical energy and how it relates to atomic structure.
* **Structure and Function**: Understanding how the structure of metals affects their electrical conductivity.

**NGSS** Next Generation Science Standards

* **MS-PS3-2**: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
* **MS-PS2-3**: Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
* **HS-PS3-5**: Develop and use models to illustrate that the release or absorption of energy from a system depends upon changes in the system’s total energy.

 **NGSSS** Next Generation Sunshine State Standards (and six additional State

* **SC.8.P.8.7**: Recognize that valence electrons determine an element's chemical properties.
* **SC.912.P.10.14**: Differentiate among conductors, semiconductors, and insulators.

By aligning these books with the relevant standards, educators can effectively teach critical scientific concepts while keeping students engaged with imaginative and relatable narratives.

**Tom the Atom, Book 11: A Day at the Museum: Mary and her friends discover the Earth's crust and materials!**

Mary and her classmate visited an exhibit at the Lawrence Hall of Science in Berkeley, California. The Earth's crust comprises atoms forming large agglomerates or molecules (chemically bonded, primarily by Covalent Bonds). In the Earth's crust, we find Minerals (homogeneous solids made of a single native element or compound), Rocks (a combination of two or more minerals), and metallic ores (Collection of pure metal atoms bound to other non-metals held together by Metallic or Covalent bonds).

## Learning Objectives (Complemental Concept: After this lesson, students will be able to understand Rocks, Minerals, and Crystals and their differences and properties in Earth Structure)

Framework for K-12 Science Education

* **ESS2.A: Earth Materials and Systems**: Understanding the composition and structure of the Earth's crust.
* **PS1.A: Structure and Properties of Matter**: Exploring the properties of minerals, rocks, and ores.

##### **Crosscutting Concepts**

* **Patterns**: Recognizing patterns in the formation of minerals and rocks.
* **Structure and Function**: Understanding how materials' atomic and molecular structure affects their properties.

 **NGSS** Next Generation Science Standards

* **MS-ESS2-1**: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
* **HS-ESS2-2**: Analyze geoscience data to claim that one change to Earth's surface can create feedback that causes changes to other Earth systems.

 **NGSSS** Next Generation Sunshine State Standards (and six additional States)

* **SC.7.E.6.1**: Describe the layers of the solid Earth.
* **SC.912.E.6.1**: Describe and differentiate the layers of Earth, including the core, mantle, and crust.

By aligning these books with the relevant standards, educators can effectively teach critical scientific concepts while keeping students engaged with imaginative and relatable narratives.

**Tom the Atom Book 12: Cuckoo Copper! Pretty and bright, you heat fast and let electrons pass!**

Copper is a colorful member of the Transition Metal family, Group 3B, a brother of Iron. Tom used the Copper to introduce atoms' "Oxidation States" concept. Copper is one of the few metals found as a native metal (Copper atoms together) or forming compounds with other atoms. Tom-the-Atom introduces the idea of Metal Alloys.

## Learning Objectives (New Concepts: After this lesson, students can review and better understand Shells and Subshells. Copper physical properties Transition Metal atoms and their characters Oxidating and Reducing Agents)

**Framework** for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**: Understanding the properties of copper, oxidation states, and metal alloys.
* **PS1.B: Chemical Reactions**: Exploring the reactivity of transition metals and how they form compounds.

##### **Crosscutting Concepts**

* **Patterns**: Recognizing patterns in oxidation states and metal properties.
* **Structure and Function**: Understanding how the structure of metals affects their properties and uses.

 NGSSNext Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
* **HS-PS1-3**: Plan and investigate to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

### **NGSSS** Next Generation Sunshine Science Standards (and six additional States)

* **SC.8.P.8.7**: Recognize the patterns and properties of elements in the periodic table.
* **SC.912.P.8.5**: Describe the properties and uses of transition metals.

By aligning these books with the relevant standards, educators can effectively teach critical scientific concepts while keeping students engaged with imaginative and relatable narratives.

**Tom the Atom, Book 13: All that glitters is not Gold; you have often heard that told!**

You, Mary, and Henry meet Gold, an atom from the Family of the Transition Metals (3B). He and nine brothers form a small subfamily called the "Noble Metals." The atoms of this subfamily (that belongs to the "Transition Metals" Family) are very reactive as single atoms but not when they are bound together with other tuples as metals. As metals, the Noble Metal atoms are happy and feel complete, meaning they do not need to interact with other atoms. Humans use the Noble Metals to facilitate electron transfer between two reacting molecules/atoms in a process called "Catalysis." Noble Metals do so without messing (reacting) with those compounds. Remember, although the single atoms are reactive, the bulk metals are inert!

## Learning Objectives (New Concepts: after this lesson, students will be able to Understand catalysis, Noble metals, Electronegativity, and the Periodic Table)

Frameworkfor K-12 Science Education

* **PS1.A: Structure and Properties of Matter**: Understanding the properties of noble metals, their reactivity, and their use in catalysis.
* **PS1.B: Chemical Reactions**: Exploring how noble metals facilitate chemical reactions without reacting themselves.

##### **Crosscutting Concepts**

* **Patterns**: Recognizing patterns in the reactivity and uses of noble metals.
* **Structure and Function**: Understanding how the structure of noble metals affects their inertness and catalytic properties.

NGSSNext Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
* **HS-PS1-2**: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
	+ The role of catalysis and noble metals in chemical reactions aligns with this performance expectation.
* **HS-PS1-5**: Apply scientific principles and evidence to explain the effects of changing the temperature or concentration of the reacting particles on the rate

NGSSSNext Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.7**: Recognize the patterns and properties of elements in the periodic table.
* **SC.912.P.8.4**: Describe the structure of atoms, including protons, neutrons, and electrons, and their locations within the atom.
* **SC.912.P.8.5**: Describe the properties and uses of noble metals.
	+ The explanation of gold's atomic structure aligns with this standard.
* **SC.912.P.8.6**: Explore the periodic table and its organization, recognizing periodic trends in the properties of elements.
	+ The focus on electronegativity and the properties of noble metals aligns with this standard.
* **SC.912.P.10.11**: Explain and compare nuclear reactions (radioactive decay, fission, and fusion), the energy changes associated with them, and their associated safety issues.
	+ Understanding the concept of catalysis and noble metals' properties fits this standard.

Application in Curriculum

**AP Chemistry**:

* **Unit 1: Atomic Structure and Properties**:
	+ Exploring the properties of transition metals and noble metals, including gold.
	+ Understanding the concept of electronegativity and its role in chemical reactions.
* **Unit 2: Molecular and Ionic Compound Structure and Properties**:
	+ Reviewing how noble metals function as catalysts in chemical reactions.

**AP Physics**:

* **Unit on Nuclear Physics**:
	+ Understanding the energy changes associated with nuclear reactions and the role of noble metals in catalysis.
	+ Exploring the differences between nuclear reactions and chemical reactions involving noble metals.

**High School Chemistry**:

* **Chapter on Atomic Structure and the Periodic Table**:
	+ Introducing students to the properties of noble metals and the concept of electronegativity.
* **A chapter on Chemical Bonding and Reactions**:
	+ Explain the role of noble metals in catalysis and how electronegativity affects chemical bonding.

By aligning this book with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom the Atom, Book 14: Get this deep into your cranium; you do not touch Uranium!**

Tom-the-Atom introduces the concept of "Radioactivity." He calls in a heavy atom called Uranium, or just U, from the Actinide family. He has 92 electrons in his shells and 92 protons in his belly. There are many Isotopes of Uranium, i.e., atoms of Uranium, but with a different number of neutrons in their belly (giving them different Atomic Weights). Isotopes are like twins; they look the same and have the same chemical properties but slightly different weights. The nuclei that have too many neutrons and protons become unstable and disintegrate. It disintegrates by emitting very energetic particles (radioactive disintegration or decay).

## Learning Objectives (New Concepts: After this lesson, students will be able to Introduce Uranium from the family of the Actinides in the f-Block of the Periodic Table. A subfamily of the 3B Transition Metals family; Introduction to Radioactivity. Introduces the energetic “particles” Alpha, Gamma, and Beta Positive and Negative; Explanation of the differences between a Nuclear Bomb and a Nuclear Power Plant)

Frameworkfor K-12 Science Education

* **PS1.C: Nuclear Processes**: Understanding radioactivity, isotopes, and radioactive decay.
* **PS1.A: Structure and Properties of Matter**: Learning about the atomic structure of Uranium.
* **ESS3.A: Natural Resources**: Exploring the use of uranium in nuclear power plants and its implications.

##### **Crosscutting Concepts**

* **Cause and Effect**: Understanding how unstable nuclei lead to radioactive decay.
* **Energy and Matter**: Exploring the energy released during radioactive decay.

 NGSS Next Generation Science Standards

* **MS-PS1-8**: Develop models to describe the atomic composition of simple molecules and extended structures.
* **HS-PS1-1**: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level.
	+ Understanding the properties of uranium and its placement in the periodic table aligns with this performance expectation.
* **HS-PS1-8**: Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
	+ Learning about radioactivity, alpha, beta, gamma particles, and nuclear reactions supports this performance expectation.
* **HS-ESS3-1**: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate changes have influenced human activity.
	+ Understanding the use of uranium in nuclear power plants and the implications of atomic energy fits with this performance expectation.

### **NGSSS** Next Generation Sunshine Science Standards (and six additional States)

* **SC.8.P.8.6**: Recognize that elements are grouped in the periodic table according to the similarities of their properties.
* **SC.912.P.8.4**: Describe the structure of atoms, including protons, neutrons, and electrons, and their locations within the atom.
	+ The explanation of uranium's atomic structure aligns with this standard.
* **SC.912.P.10.11**: Explain and compare nuclear reactions (radioactive decay, fission, and fusion), the energy changes associated with them, and their associated safety issues.

Application in Curriculum

**AP Chemistry**:

* **Unit 1: Atomic Structure and Properties**:
	+ Exploring the properties of actinides, including uranium.
	+ Understanding the concept of radioactivity and nuclear processes.
* **Unit 2: Molecular and Ionic Compound Structure and Properties**:
	+ Reviewing how uranium forms compounds and its radioactive properties.

**AP Physics**:

* **Unit on Nuclear Physics**:
	+ Learning about radioactive decay, alpha, beta, and gamma particles, and the differences between nuclear bombs and power plants.
	+ Understanding the energy changes associated with nuclear reactions.

**High School Chemistry**:

* **Chapter on Atomic Structure and the Periodic Table**:
	+ Introducing students to the properties of actinides, including uranium.
* **Chapter on Nuclear Chemistry**:
	+ Explaining radioactivity, types of radioactive particles, and nuclear reactions.

By aligning this book with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom the Atom, Book 15: Aluminum is my name; opportunism is my aim!**

This time, you will visit the town where the Atoms live. You will stop at the "Basic Metals" neighborhood to meet Aluminum (Al, his nickname). Aluminum is a light, gray, and shiny element in Column 13 or Group 3A of the Periodic Table (do not confuse with family Group 3B of the Transition Metals). He has three valence electrons in his outermost shell. Aluminum metal (many atoms) develops a weak Oxide layer (Aluminum bound to Oxygen) when in contact with the Oxygen in the air. That layer is so thin that it is invisible to the naked eye. The film protects the metal from corrosion (Oxygen or water reaction with Aluminum). When Aluminum has that thin layer, humans say it is Passive. Aluminum can be passive and used to fabricate many structures, such as airplanes. If Aluminum has no passive layer, it can burn actively in the air, like a Fourth of July sparkler! He exhibits a bipolar character!

## Learning Objectives (New Concepts: After this lesson, students will be able to: Aluminum Anodization. Introduction to the Basic Metal family. Introduction to the solid batteries concepts)

### **Framework** for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ Understanding the properties and behaviors of aluminum and other essential metals.
	+ Learning about anodization and how it protects aluminum from corrosion.
* **PS1.B: Chemical Reactions**:
	+ Exploring the concept of solid batteries and how they function.

##### **Crosscutting Concepts:**

* **Patterns**:
	+ Recognizing patterns in the properties of metals and their reactions.
* **Structure and Function**:
	+ Understanding how the structure of aluminum and its anodization process influences its properties and uses.

 **NGSS** Next Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The book’s explanation of aluminum's atomic structure and properties supports this performance expectation.
* **HS-PS1-3**: Plan and investigate to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
	+ Understanding aluminum anodization and solid batteries aligns with this performance expectation.
* **HS-PS3-3**: Design, build, and refine a device that works within given constraints to convert one form of energy into another.
	+ Exploring the concept of solid batteries and their energy storage capabilities supports this performance expectation.

### NGSSS Next Generation Sunshine Science Standards (and six additional States)

* **SC.8.P.8.7**: Recognize that elements are grouped in the periodic table according to the similarities of their properties.
	+ The book’s discussion on the properties of aluminum and other essential metals aligns with this standard.
* **SC.912.P.8.5**: Describe the properties of the elements in the periodic table based on their atomic structure.
	+ The explanation of aluminum’s properties and anodization process fits this standard.
* **SC.912.P.10.14**: Differentiate among conductors, semiconductors, and insulators.
	+ Understanding the role of aluminum in solid batteries aligns with this standard.

Application in Curriculum

**AP Chemistry**:

* **Unit 1: Atomic Structure and Properties**:
	+ Exploring the properties of essential metals, including aluminum.
* **Unit 2: Molecular and Ionic Compound Structure and Properties**:
	+ Reviewing how anodization protects aluminum from corrosion.
* **Unit 9: Applications of Thermodynamics**:
	+ Understanding how solid batteries store and release energy.

**High School Chemistry**:

* **Chapter on Atomic Structure and the Periodic Table**:
	+ Introducing students to the properties of essential metals and their reactivity.
* **The chapter on Chemical Bonding and Reactions**:
	+ Explaining the process of anodization and its effects on aluminum.
* **Chapter on Energy Storage and Batteries**:
	+ Exploring the concept of solid batteries and their practical applications.

By aligning this book with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom the Atom, Book 16: Have you heard of Silicon Valley? It is an economic rally!**

You will visit Tom-the-Atom's World to meet Silicon and learn about Semiconductors. This time, you see the beautiful and wealthy neighborhood of the Semi-Metals. The community is small. Silicon is in the Periodic Table in Column 14 or Group 4A. Like his cousin, Carbon, he has four valence electrons in his outermost Valence shell. He is in the 3rd row, just below that of Tom-the-Atom (in the second row), meaning he has three shells. Silicon is versatile and essential to humans.

## Learning Objectives (New Concepts: After this lesson, students will be able to: SILICON an atom from the family of the Metalloids. Positive and Negative Doping, Introductory Concept of Semiconductors. Concept of solid Batteries).

### **Framework** for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ Understanding the properties and behavior of silicon as a semi-metal (metalloid).
	+ Learning about doping and its effects on silicon's electrical properties.
* **PS3.B: Conservation of Energy and Energy Transfer**:
	+ Exploring how semiconductors and solid batteries function and their importance in technology.

##### **Crosscutting Concepts:**

* **Patterns**:
	+ Recognizing patterns in the periodic table and how they relate to the properties of metalloids and their transition between metals and non-metals.
* **Structure and Function**:
	+ Understanding how the structure of silicon and doping affects its function as a semiconductor.

 NGSSNext Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The book’s explanation of silicon’s atomic structure and properties supports this performance expectation.
* **HS-PS1-1**: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level.
	+ Understanding the properties of silicon and metalloids aligns with this performance expectation.
* **HS-PS3-3**: Design, build, and refine a device that works within given constraints to convert one form of energy into another.
	+ Exploring the concept of solid batteries and their energy storage capabilities supports this performance expectation.

### **NGSSS** Next Generation Sunshine Science Standards (and six additional States)

* **SC.8.P.8.7**: Recognize that elements are grouped in the periodic table according to the similarities of their properties.
	+ The book’s discussion on the properties of silicon and other semi-metals aligns with this standard.
* **SC.912.P.8.5**: Describe the properties of the elements in the periodic table based on their atomic structure.
	+ The explanation of silicon’s properties, doping, and semiconductor role fits this standard.
* **SC.912.P.10.14**: Differentiate among conductors, semiconductors, and insulators.
	+ Understanding the role of silicon in semiconductors and solid batteries aligns with this standard.

Application in Curriculum

**AP Chemistry**:

* **Unit 1: Atomic Structure and Properties**:
	+ Exploring the properties of semi-metals, including silicon.
* **Unit 2: Molecular and Ionic Compound Structure and Properties**:
	+ Reviewing how doping affects silicon's electrical properties.
* **Unit 9: Applications of Thermodynamics**:
	+ Understanding how solid batteries store and release energy.

**High School Chemistry**:

* **Chapter on Atomic Structure and the Periodic Table**:
	+ Introducing students to the properties of semi-metals and their reactivity.
* **A chapter on Chemical Bonding and Reactions**:
	+ Explaining the process of doping and its effects on silicon.
* **Chapter on Energy Storage and Batteries**:
	+ Exploring the concept of solid batteries and their practical applications.

By aligning this book with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom the Atom, Book 17: To review from the blue, make your mind glue the content, and forget the nonsense!**

Mary and Henry invited their friends to play science at home. They have a tough time deciding where to start. Mary agreed to instruct her friends about Aluminum and build a battery at home, with Mom's help and permission. Henry chose to talk about semiconductors and Silicon with Dad's help and supervision.

## Learning Objectives (A Review: After this lesson, students will review the concepts learned on Silicon, an atom from the family of Metalloids. Positive and Negative Doping. Introductory concept of Semiconductors and their use in solid Batteries)

Framework for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**: Reviewing the properties and behaviors of aluminum and silicon.
* **PS3.B: Conservation of Energy and Energy Transfer**: Exploring the transfer of electrical energy in semiconductors.

##### **Crosscutting Concepts**

* **Patterns**: Recognizing patterns in the properties and behaviors of materials.
* **Energy and Matter**: Exploring the transfer of energy in electrical circuits.

 **NGSS** Next Generation Science Standard

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
* **HS-PS3-3**: Design, build, and refine a device that works within given constraints to convert one form of energy into another.
	+ Exploring the concept of solid batteries and their energy storage capabilities supports this performance expectation.

**NGSSS** Next Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.7**: Recognize that valence electrons determine an element's chemical properties.
* **SC.912.P.8.5**: Describe the properties of the elements in the periodic table based on their atomic structure.
	+ The explanation of silicon’s properties, doping, and semiconductor role fits this standard.
* **SC.912.P.10.14**: Differentiate among conductors, semiconductors, and insulators.

Application in Curriculum

**AP Chemistry**:

* **Unit 1: Atomic Structure and Properties**:
	+ Exploring the properties of essential metals, including aluminum.
* **Unit 2: Molecular and Ionic Compound Structure and Properties**:
	+ Reviewing how anodization protects aluminum from corrosion.
* **Unit 9: Applications of Thermodynamics**:
	+ Understanding how solid batteries store and release energy.

**High School Chemistry**:

* **Chapter on Atomic Structure and the Periodic Table**:
	+ Introducing students to the properties of essential metals and their reactivity.
* **The chapter on Chemical Bonding and Reactions**:
	+ Explaining the process of anodization and its effects on aluminum.
* **Chapter on Energy Storage and Batteries**:
	+ Exploring the concept of solid batteries and their practical applications.

By aligning this book with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom the Atom, Book 18: Nitrogen Cycle is like the wheel of a motorcycle!**

Tom the Atom introduces a new member of the Non-Metals family to you. Humans classify molecules into two large categories: Organics and Inorganics. Organics are those large molecules when Tom, the Atom, the Carbon atom, is the central piece. Most of the time, Tom is with Hydrogen (Column 1), Oxygen (Column 16), and Nitrogen (Column 15). Why are organic molecules so important? Because they form the essence of life: plants, animals, and humans. The Nitrogen symbol is N and belongs to Group 5A (Column 15), meaning it has 5 Valence electrons. Nitrogen molecules (N2) make up 80% of our atmosphere.

## Learning Objectives (New Concept: After this lesson, students will review the concepts learned on nitrogen atoms, their family and characteristics, fertilizers, and the nitrogen cycle).

### **Framework** for K-12 Science Education

* **LS1.C: Organization for Matter and Energy Flow in Organisms**:
	+ Understanding the role of nitrogen in living organisms and its importance for life.
* **ESS2.A: Earth Materials and Systems**:
	+ Exploring the nitrogen cycle and its significance in ecosystems.

**Crosscutting Concepts**:

* **Cycles**:
	+ Understanding the nitrogen cycle and how nitrogen moves through living and non-living systems.
* **Energy and Matter**:
	+ Exploring the flow of nitrogen through different components of the environment.

 NGSSNext Generation Science Standards

* **MS-LS2-3**: Develop a model to describe the cycling of matter and energy flow among an ecosystem's living and nonliving parts.
	+ The book’s explanation of the nitrogen cycle supports this performance expectation.
* **HS-ESS2-6**: Develop a quantitative model to describe carbon cycling among the hydrosphere, atmosphere, geosphere, and biosphere.
	+ Understanding the nitrogen cycle and its interactions within Earth systems aligns with this performance expectation.
* **HS-LS1-7**: Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken, and the bonds in new compounds are formed, resulting in a net energy transfer.
	+ Exploring the role of nitrogen in fertilizers and its impact on plant growth fits this performance expectation.

NGSSSNext Generation Sunshine State Standards (and six additional States)

* **SC.7.L.17.2**: Explain and describe the nitrogen cycle.
	+ The book’s discussion on the nitrogen cycle aligns with this standard.
* **SC.912.L.17.9**: Describe the carbon and nitrogen cycles, including the processes involved.
	+ Understanding the role of nitrogen in ecosystems and its movement through the environment fits this standard.
* **SC.912.L.18.7**: Identify the reactants, products, and essential functions of photosynthesis.
	+ Exploring the role of nitrogen in fertilizers and its impact on plant growth aligns with this standard.

Application in Curriculum

**Middle School Science Curriculum**:

* **Unit on Ecosystems and Matter Cycling**:
	+ Introducing students to the nitrogen cycle and its importance in ecosystems.
	+ Exploring how nitrogen is used in fertilizers to enhance plant growth.

**High School Biology and Environmental Science**:

* **Chapter on Biogeochemical Cycles**:
	+ Understanding the nitrogen cycle and its interactions with other cycles, such as the carbon cycle.
* **Chapter on Plant Physiology and Growth**:
	+ Exploring the role of nitrogen in fertilizers and how it affects plant growth.

By aligning this book with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom the Atom, Book 19: Do not eat Sulfur, or you may suffer!**

The Children met Sulfur, and the Polymerization process was described to them. Sulfur occupies Column 16 (or Group 6A) in the Periodic Table, i.e., Sulfur has 6 "hands" or Valence electrons, the same as her brother Oxygen. Sulfur is under Oxygen in the third row of the Periodic Table, indicating she has three shells. She is bright yellow and can smell horrible when combined with Hydrogen (H2S). Bacteria can produce H2S, which has a characteristic odor like rotten eggs. Sulfur can be toxic and damaging to human bodies if used excessively. Sulfur has a strange characteristic when heated: it becomes thicker (more viscous) rather than thinner (less dense) like most substances.

### **Learning Objectives** (New Concepts: After this lesson, students will review the concepts learned on Sulfur Atoms and their place in the Periodic Table Polymerization Monomers and Polymers)

### **Framework** for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ Understanding the properties and behavior of sulfur and its place in the periodic table.
	+ Learning about monomers, polymers, and the process of polymerization.
* **PS1.B: Chemical Reactions**:
	+ Exploring how sulfur is used in the vulcanization of rubber and other polymerization processes.

##### **Crosscutting Concepts**:

* **Patterns**:
	+ Recognizing patterns in the periodic table and how they relate to non-metal properties like sulfur.
* **Structure and Function**:
	+ Understanding how the structure of monomers leads to the formation of polymers and their properties.

NGSSNext Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The book’s explanation of sulfur’s atomic structure and polymerization supports this performance expectation.
* **HS-PS1-2**: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
	+ Understanding the role of sulfur in chemical reactions and polymerization aligns with this performance expectation.
* **HS-PS2-6**: Communicate scientific and technical information about why the molecular-level structure is essential in designing materials.
	+ Exploring how the molecular structure of polymers affects their properties supports this performance expectation.

 NGSSS Next Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.7**: Recognize that elements are grouped in the periodic table according to the similarities of their properties.
	+ The book’s discussion on the properties of sulfur and its place in the periodic table aligns with this standard.
* **SC.912.P.8.6**: Explore the periodic table and its organization, recognizing periodic trends in the properties of elements.
	+ Understanding the properties and placement of sulfur in the periodic table fits with this standard.
* **SC.912.P.8.9**: Apply the law of conservation of mass to chemical reactions.
	+ The focus on chemical reactions involving sulfur and polymerization aligns with this standard.

Application in Curriculum

**Middle School Science Curriculum**:

* **Unit on Chemical Reactions and Properties of Matter**:
	+ Introducing students to the properties of sulfur and its role in chemical reactions.
	+ Exploring the concepts of monomers and polymers through hands-on activities.
* **Unit on Periodic Table and Element Properties**:
	+ Understanding the placement of sulfur in the periodic table and its properties.

**High School Chemistry**:

* **Chapter on Atomic Structure and the Periodic Table**:
	+ Introducing students to the properties of non-metals, including sulfur.
* **A chapter on Chemical Bonding and Reactions**:
	+ Explain the process of polymerization and the role of sulfur in these reactions.
* **A chapter on Organic Chemistry and Polymers**:
	+ Exploring the formation of polymers from monomers and their practical applications, including vulcanization of rubber.

By aligning this book with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom the Atom, Book 20: Chlorine, strong, green, lean, and mean!**

Chlorine is an atom from the Family of Halogens. She is well placed to reinforce the concept of Electronegativity (Book 13) and introduce the concepts of Reduction and Oxidation processes. Chlorine is in Column 17 (or Group 7A) of the Periodic Table. She has 7 "hands" or Valence electrons and only one "empty sleeve" in her outermost shell (to add to 7+1=8). She likes to steal an electron to fill up her outer shell. You will learn that an "Oxidizing Agent" is an aggressive atom (or compound) that takes "hands" or Valence electrons rather than give them away, a real thief! She has a large Electronegativity (close to 4!). A "Reducing Agent" is the opposite. Reducing Agents like to give away their Valence electrons (as the atoms in Columns 1 and 2 (Groups 1A and 2A) from the Periodic Table) and have low Electronegativity.

### **Learning Objectives** (New Concepts: After this lesson, students will review the concepts learned on: No Metals representative: Chlorine Oxidation- Reduction ionic bond electron affinity Halogens family)

### **Framework** for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ Understanding the properties and behavior of chlorine and other halogens.
	+ Learning about electron affinity and how it influences chemical bonding.
* **PS1.B: Chemical Reactions**:
	+ Exploring oxidation-reduction reactions and the roles of reducing agents and oxidizing agents.

##### **Crosscutting Concepts:**

* **Patterns**:
	+ Recognizing patterns in the periodic table and how they relate to the properties of halogens.
* **Cause and Effect**:
	+ Understanding how electron affinity and reactivity lead to oxidation-reduction reactions.

 NGSS Next Generation Science Standards

* **MS-PS1-2**: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
	+ The book’s explanation of chlorine’s properties and reactions supports this performance expectation.
* **HS-PS1-1**: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level.
	+ Understanding electron affinity and the behavior of halogens aligns with this performance expectation.
* **HS-PS1-2**: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
	+ The focus on oxidation-reduction reactions and the roles of reducing and oxidizing agents fits this performance expectation.

 NGSSSNext Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.7**: Recognize that elements are grouped in the periodic table according to the similarities of their properties.
	+ The book’s discussion on the properties of halogens and their place in the periodic table aligns with this standard.
* **SC.912.P.8.4**: Describe the structure of atoms, including protons, neutrons, and electrons, and their locations within the atom.
	+ Understanding chlorine’s atomic structure and electron affinity fits with this standard.
* **SC.912.P.8.10**: Describe oxidation-reduction reactions and their applications.
	+ The explanation of oxidation-reduction reactions and the roles of reducing and oxidizing agents aligns with this standard.

Application in Curriculum

**Middle School Science Curriculum**:

* **Unit on Chemical Reactions and Properties of Matter**:
	+ Introducing students to the properties of chlorine and other halogens.
	+ Exploring the concepts of electron affinity and ionic bonding.
* **Unit on Periodic Table and Element Properties**:
	+ Understanding the placement of halogens in the periodic table and their properties.

**High School Chemistry**:

* **Chapter on Atomic Structure and the Periodic Table**:
	+ Introducing students to the properties of halogens and their behavior.
* **A chapter on Chemical Bonding and Reactions**:
	+ Explaining electron affinity, oxidation-reduction reactions, and the roles of reducing and oxidizing agents.
* **A chapter on Redox Chemistry**:
	+ Exploring the practical applications of oxidation-reduction reactions and how they are used in various processes.

By aligning this book with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom the Atom, Book 21: Argon marches on, watchful and chock full!**

Noble Gas atoms do not interact with other atoms because their Valence shell (or sub-shells) is FULL. The Noble Gases family members have all their shells, including their outermost Valence shell, full of electrons to their rim (2 for the Helium atom and 8 for all the others). They do not need to "handshake" with any other atom to borrow or give away electrons, so they are not reactive! They do not form chemical bonds with anyone. They are a family of 6 existing siblings.

### **Learning Objectives** (New Concepts: After this lesson, students will review the concepts learned on NOBLE GASES idea of full valence band inactive atoms)

### **Framework** for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ Understanding the properties and behavior of noble gases, including their entire valence shell.
	+ Learning why noble gases are non-reactive and do not form chemical bonds.

##### **Crosscutting Concepts:**

* **Patterns**:
	+ Recognizing patterns in the periodic table and how they relate to the properties of noble gases.
* **Stability and Change**:
	+ Understanding how an entire valence shell leads to the stability and inertness of noble gases.

 NGSSNext Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The book’s explanation of noble gases' atomic structure and whole valence shells supports this performance expectation.
* **HS-PS1-1**: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level.
	+ Understanding the properties of noble gases and their placement in the periodic table aligns with this performance expectation.
* **HS-PS1-3**: Plan and investigate to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
	+ Exploring how the entire valence shell of noble gases influences their non-reactivity supports this performance expectation.

 NGSSSNext Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.7**: Recognize that elements are grouped in the periodic table according to the similarities of their properties.
	+ The book’s discussion on the properties of noble gases and their placement in the periodic table aligns with this standard.
* **SC.912.P.8.4**: Describe the structure of atoms, including protons, neutrons, and electrons, and their locations within the atom.
	+ Understanding noble gases’ atomic structure and their whole valence shells fits with this standard.
* **SC.912.P.8.6**: Explore the periodic table and its organization, recognizing periodic trends in the properties of elements.
	+ Explaining noble gases’ properties and stability aligns with this standard.

Application in Curriculum

**Middle School Science Curriculum**:

* **Unit on Chemical Reactions and Properties of Matter**:
	+ Introducing students to the properties of noble gases and why they are non-reactive.
* **Unit on Periodic Table and Element Properties**:
	+ Understanding the placement of noble gases in the periodic table and their unique properties.

**High School Chemistry**:

* **Chapter on Atomic Structure and the Periodic Table**:
	+ Introducing students to the properties of noble gases and their behavior.
* **The chapter on Chemical Bonding and Reactions**:
	+ Explaining why noble gases do not form chemical bonds due to their entire valence shell.
* **Chapter on Stability and Reactivity**:
	+ Exploring the concept of atomic stability and how it relates to the inertness of noble gases.

By aligning this book with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom the Atom, Book 22: Take a test, and I will confess how impressed you were with me!**

Today is Friday, but Tom-the-Atom wants to invite you, Henry, and Mary back to the Atom's School. Along with Henry, Mary, and Tom the Atom, you will review some concepts you learned in Book 6-Book 21 of the Series Tom the Atom. Reading Books 1 to 21 lets you know which atoms you can manage closely and which are to be kept at a distance and handled cautiously. What gives atoms character, and how molecules and materials are formed?

### **Learning Objectives** (A Review Books 6-21: After this lesson, students will review the concepts learned, such as atom families, periodic Table, atomic bodies and valence electrons, metals, metalloids, and non-metals classification, covalent, ionic, and metallic bonds, electrons- conductors and insulators, electricity, and potential difference, static and dynamic electricity, radiation and nuclei decay, the nitrogen cycle, polymers, oxidizer and reducing agents, Learn about metal alloys, and corrosion of metals)

Frameworkfor K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ Book 22 covers the states of matter (solids, liquids, and gases) and the properties of solid materials based on their molecular arrangement, which aligns with the structure and properties of matter.
* **PS1.B: Chemical Reactions**:
	+ The book's explanation of different types of bonding, including hydrogen bonding and dipole-dipole interactions, aligns with the understanding of chemical reactions and bonding.

##### **Crosscutting Concepts:**

* + **Patterns**: Recognizing patterns in the periodic table and the behavior of elements.
	+ **Cause and Effect**: Understanding how chemical reactions occur and their effects.
	+ **Energy and Matter**: Exploring how energy and matter interact in chemical reactions.

 NGSS Next Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ Book 22's coverage of the arrangement of molecules in solids and diverse types of bonding supports this performance expectation.
* **PS1.A: Structure and Properties of Matter**: Understanding the structure of atoms and molecules and how they form compounds.
* **PS1.B: Chemical Reactions**: Exploring how atoms and molecules interact to form new substances.
* **PS3.D: Energy in Chemical Processes and Everyday Life**: Investigating energy changes in chemical reactions.
* **ETS1.B: Developing Possible Solutions**: Designing experiments to evaluate hypotheses about chemical properties and reactions.

 NGSSSNext Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.4**: Classify and compare substances based on characteristic physical properties.
	+ The discussion of solids, liquids, and gases, as well as crystallinity, fits with classifying and comparing substances based on their properties.
* **SC.912.P.8.1**: Differentiate among the different states of matter and understand the structure of atoms.
* **SC.912.P.8.4**: Explore the arrangement of electrons in an atom and how it relates to the periodic table.
* **SC.912.P.8.5**: Recognize patterns and relationships in the periodic table and the properties of elements.
* **SC.912.P.8.6**: Understand the properties of metals, non-metals, and metalloids.
* **SC.912.P.8.7**: Identify types of bonds (covalent, ionic, and metallic) and how they form.
* **SC.912.P.10.13**: Understand the basic principles of electricity and the potential difference.
* **SC.912.P.10.14**: Explore the concepts of static and dynamic electricity.
* **SC.912.P.10.16**: Investigate the properties of conductors and insulators.
* **SC.912.P.10.17**: Understand the principles of nuclear reactions, including radiation and nuclei decay.
* **SC.912.L.17.8**: Analyze the nitrogen cycle and its importance to living organisms.
* **SC.912.P.8.11**: Learn about polymers, their formation, and their applications.
* **SC.912.P.8.12**: Understand oxidation-reduction reactions and the role of oxidizers and reducing agents.
* **SC.912.P.10.15**: Learn about the properties and uses of metal alloys.
* **SC.912.P.8.13**: Investigate the processes and effects of corrosion on metals

Application in Curriculum

* **Middle School Science Curriculum**: Teachers can use Book 22 to introduce and reinforce concepts related to states of matter, molecular structure, and bonding. It can be integrated into lessons on physical science and chemistry.
* **High School Science Curriculum**: The book can be a supplementary resource to deepen students' understanding of crystallinity and molecular interactions in more advanced chemistry courses.

By aligning Tom the Atom Book 22 with these standards, educators can ensure they effectively teach critical scientific concepts while keeping students engaged with relatable and interesting content.

**Tom the Atom, Book 23: Crystalline in the dark, all you see are the sparks!**

Materials can be solids, liquids, or gases. Solid materials (made of many molecules) have properties that depend on how the molecules are arranged to form the solid: Crystallinity. Tom-the-Atom wants to tell you more about the crystal structures of solids and their importance in understanding the material's behavior.

The types of bonds the atoms use to form molecules and materials are revised, and a different bonding type, H-Bonding, which belongs to a more general Dipole-Dipole molecules interaction, is explained. From Book 23 until Book 31, you will learn much about Crystals in the Universe, the Solar System, and your planet, Earth!

### **Learning Objectives** (New Concepts Books 23-31: students will review the Solid Structures: concepts learned—mechanical properties of materials (Toughness, hardness, Elastic, plastic, brittle, and ductile). Dipole-dipole bond hydrogen bonding is reviewed. Crystalline structure of materials)

Framework for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ Understanding the properties of solids, liquids, and gases and how molecular arrangement affects the behavior of solids.
	+ Exploring different types of bonds, including hydrogen bonding and dipole-dipole interactions.

##### **Crosscutting Concepts:**

* **Patterns**:
	+ Recognizing patterns in the arrangement of molecules and the resulting properties of materials.
* **Structure and Function**:
	+ Understanding how the structure of crystals and types of bonds influence the function and properties of materials.

NGSSNext Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The book’s focus on crystallinity and molecular bonding supports this performance expectation.
* **HS-PS1-3**: Plan and investigate to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
	+ Understanding the types of bonding and molecular interactions aligns with this performance expectation.

 NGSSSNext Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.4**: Classify and compare substances based on characteristic physical properties.
	+ The book’s discussion on the properties of solids, liquids, and gases fits this standard.
* **SC.912.P.8.7**: Interpret formula representations of molecules and compounds in terms of composition and structure.
	+ The explanation of different types of bonds and molecular interactions aligns with this standard.

**Application in Curriculum**

* **Middle School Science Curriculum**: Teachers can use Book 23 to introduce and reinforce concepts related to states of matter, crystallinity, and molecular bonding. It can be integrated into lessons on physical science and chemistry.
* **High School Science Curriculum**: The book can serve as a supplementary resource to deepen students' understanding of crystallinity, molecular interactions, and the properties of materials.

By aligning Tom the Atom, Book 23, with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom the Atom, Book 24: I will smooth the edges from my roughness and lose the amorphous layer in my toughness!**

Today, Tom-the-Atom expands the concepts of crystals, including crystal types and how the material's crystalline structure is essential to determine the material's properties. A fable about a war between crystals in the Universe is used to introduce fundamental concepts. In doing so, Tom the Atom reminds you about the characteristics of our Universe, Solar system, and planet Earth!

### **Learning Objectives** (New Concepts Books 23-31: Students will review the concepts learned after this lesson. The type of solid crystals depends on the kind of bonds. Atomic structure of crystals. Seven crystal systems. Relation between crystalline structure and physical properties. Crystal impurities and imperfections. Type of defects)

Frameworkfor K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ The book's focus on crystalline structures and their properties aligns with understanding how the arrangement of particles affects material properties.

##### **Crosscutting Concepts:**

* **Structure and Function**:
	+ The relationship between crystal structures and material properties ties into this concept.

NGSS Next Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The book's discussion of crystalline structures supports this performance expectation.
* **HS-PS1-3**: Plan and investigate to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
	+ The book's exploration of crystalline structures and their properties aligns with this performance expectation.

 NGSSSNext Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.4**: Classify and compare substances based on characteristic physical properties.
	+ The book's focus on crystalline structures and their properties fits this standard.
* **SC.912.P.8.7**: Interpret formula representations of molecules and compounds in terms of composition and structure.
	+ The book's explanation of crystalline structures aligns with this standard.

**Application in Curriculum**

* **Middle School Science Curriculum**: Teachers can use Book 24 to introduce and reinforce concepts related to crystalline structures and their properties.
* **High School Science Curriculum**: The book can be a supplementary resource to deepen students' understanding of crystallinity and material properties in more advanced chemistry courses.

By aligning Tom the Atom Book 24 with these standards, educators can ensure they effectively teach essential scientific concepts while keeping students engaged with relatable and interesting content.

**Tom the Atom, Book 25: If all belong to the Universe, where is the place for "I" and "Mine"? Where is my "Shrine"?**

This Book teaches you about the Universe in which you live. You will learn exciting concepts about Gravity, "Dark Matter," and "Dark Energy." You will know how tiny and essential you are compared to the Universe. You will learn to respect Nature and put yourself in the Universe's perspective. This Book prepares the stage for the following books, which are genuinely fascinating fables used to teach more about the crystals in our planet Earth, the solar system, and the entire Universe.

### **Learning Objectives** (New Concepts Books 23-31: Students will review the concepts learned after this lesson—creation of the universe and formation of galaxies. Physical characteristics of the universe include the size of the universe. Difference between stars and planets. Galaxies and the solar system. Gravity. Newton observation. Dark matter and dark energy. Composition of the universe)

Frameworkfor K-12 Science Education

* **ESS1.A: The Universe and Its Stars**: The book's content on the Universe, gravity, and dark matter aligns with understanding the Universe and its stars.
* **ESS1.B: Earth and the Solar System**: The book’s perspective on Earth concerning the broader Universe fits within this core idea.
* **PS2.B: Types of Interactions**: The discussion of gravitational forces aligns with understanding the types of interactions in the physical sciences.

##### **Crosscutting Concepts:**

* **Scale, Proportion, and Quantity**: Emphasizing the scale of the Universe and one’s place within it ties into understanding the vastness of space and the relative size of objects.
* **Patterns**: Identifying patterns in the cosmos and understanding the distribution of dark matter and dark energy.

NGSS Next Generation Science Standards

* **MS-ESS1-2**: Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
	+ The book’s exploration of gravity supports this performance expectation.
* **HS-ESS1-2**: Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the Universe.
	+ The content on dark matter and dark energy aligns with this performance expectation.

NGSSS Next Generation Sunshine State Standards (and six additional States)

* **SC.8.E.5.4**: Explore the law of universal gravitation by explaining gravity's role in forming planets, stars, and solar systems and determining their motions.
	+ The book’s content on gravity aligns with this standard.
* **SC.912.E.5.2**: Analyze the relationships between the various parts of the electromagnetic spectrum and their application to an understanding of the structure and composition of the Universe.
	+ The discussion on dark matter and dark energy aligns with this standard.

**Application in Curriculum**

* **Middle School Science Curriculum**: Teachers can use Book 25 to introduce and reinforce concepts related to the Universe, gravity, dark matter, and dark energy. It can be integrated into lessons on astronomy and physical sciences.
* **High School Science Curriculum**: The book can serve as a supplementary resource to deepen students’ understanding of cosmology and the physical principles that govern the Universe.

By aligning Tom the Atom Book 25 with these standards, educators can effectively teach important scientific concepts and foster a greater appreciation for the Universe and our place within it.

**Tom the Atom, Book 26: Ice Glutton Giant feasts upon his immense beauty and intoxicated eating. But without a humble spirit, there cannot be abundant beauty! Part I.**

Ice-Glutton Giant, a one-eye diamond, wants to invade Earth and devour all those beautiful quartz crystals in the Naica mine. He thinks that if he eats those enormous pieces of quartz in the Naica mines, he will grow taller and stronger. All crystals on Earth get together and join with their siblings and cousins from Jupiter! Love trumps intoxicated eating. A fascinating film shows the fight for beauty and abundance between the crystals in our Solar System!

Learning Objectives (New Concepts Books 23-31:After this lesson, students will review the concepts learned on the solar system. Jupiter and Earth characteristics)

Frameworkfor K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ The book's focus on quartz crystals and their properties, formation, and structure aligns with this core idea.
* **ESS1.B: Earth and the Solar System**:
	+ By discussing crystals on Earth and their interactions with those from Jupiter, the book fits within the core idea of understanding the broader context of Earth within the Solar System.

##### **Crosscutting Concepts:**

* **Patterns**:
	+ Recognizing and understanding patterns in the formation and structure of crystals.
* **Cause and Effect**:
	+ Exploring the effects of interactions between different types of crystals and the concept of "intoxicated eating" as a metaphor for consumption and growth.

 NGSSNext Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The book’s exploration of the crystal structures of quartz supports this performance expectation.
* **MS-ESS1-3**: Analyze and interpret data to determine scale properties of objects in the Solar System.
	+ The interaction between Earth and Jupiter's crystals aligns with this performance expectation.

 NGSSSNext Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.4**: Classify and compare substances based on characteristic physical properties.
	+ The book’s discussion on quartz crystals' properties fits this standard.
* **SC.912.E.5.3**: Describe and identify patterns in the organization of systems at different scales using models.
	+ The interaction between crystals from different celestial bodies aligns with this standard.

Application in Curriculum

* **Middle School Science Curriculum**: Teachers can use Book 26 to introduce and reinforce concepts related to crystal structures, their properties, and their significance in both Earth and space sciences. It can be integrated into physical science, chemistry, and astronomy lessons.
* **High School Science Curriculum**: The book can serve as a supplementary resource to deepen students' understanding of crystallinity and the physical interactions between materials in our Solar System.

By aligning Tom the Atom Book 26 with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom-the-Atom, Book 27: Gluttony has killed more than the sword! Part II.**

A fascinating fable in the world of atoms continues. In Part II, all the diamonds from Jupiter continue with their plan, which started in Book 26, to hinder the evil Ice-Glutton Giant from eating them away. Planet Earth is their next stop.

### **Learning Objectives** (New Concepts Books 23-31:After this lesson, students will review the concepts learned on The type of crystalline structure and speed of light. Gypsum mines structures and composition)

Framework for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ The book's continuation of exploring the properties of diamonds and crystals aligns with understanding the structure and properties of matter.
* **ESS1.B: Earth and the Solar System**:
	+ The narrative involving Jupiter and Earth fits within the broader understanding of Earth in the context of the Solar System.

##### **Crosscutting Concepts:**

* **Cause and Effect**:
	+ The book explores the cause-and-effect relationships between the Ice-Glutton Giant's actions and the responses of the diamonds, helping students understand these interactions.
* **Systems and System Models**:
	+ The interconnected story involving different celestial bodies can help illustrate the concept of systems and their interactions.

 NGSSNext Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The exploration of diamond structures supports this performance expectation.
* **MS-ESS1-3**: Analyze and interpret data to determine scale properties of objects in the Solar System.
	+ The interactions between Jupiter's diamonds and Earth align with understanding the scale of objects in the Solar System.

NGSSSNext Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.4**: Classify and compare substances based on characteristic physical properties.
	+ The book's focus on the properties of diamonds and crystals fits with this standard.
* **SC.912.E.5.3**: Describe and identify patterns in the organization of systems at different scales using models.
	+ The narrative involving crystals from different celestial bodies aligns with this standard.

**Application in Curriculum**

* **Middle School Science Curriculum**: Teachers can use Book 27 to introduce and reinforce concepts related to crystal structures, their properties, and the interactions between different materials in the Solar System. It can be integrated into physical science, chemistry, and astronomy lessons.
* **High School Science Curriculum**: The book can serve as a supplementary resource to deepen students' understanding of crystallinity and the physical interactions between materials in our Solar System.

Educators can effectively teach critical scientific concepts by aligning Tom the Atom Book 27 with these standards while engaging students with an imaginative and relatable narrative.

**Tom the Atom, Book 28: Think of us as pistols or African Lions with glimmering teeth that shine like white crystals! Part III.**

The plan to hinder the evil monster from Jupiter starts to develop. PP-Pinky, the pretty pink diamond from Jupiter, lands on planet Earth, seeking the help of King Naicu, the king of the giant gypsum crystals from the Naica mines. Blackie Diamond and all the Jupiter generals developed the plans. PP-Pinky meets King Naicu shortly after landing near the secret Naica Mine. It is a fabulous film continuation that will teach you a great deal about the pretty crystals on Planet Earth and their essential characteristics. You will be fascinated with the film and the information you will learn about crystals.

### **Learning Objectives** (New Concepts Books 23-31: After this lesson, students will review the concepts learned about minerals on the earth's crust, gypsum, petrified wood, and salt mines, amorphous versus crystalline rocks, and rock characteristics (transparent, translucent, opaque).

FrameworkforK-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ The book focuses on different types of crystals, including gypsum and diamonds, and their properties align with understanding the structure and properties of matter.
* **ESS1.B: Earth and the Solar System**:
	+ The interactions between crystals from Jupiter and those on Earth fit within the broader context of understanding the Earth and the Solar System.

##### **Crosscutting Concepts:**

* **Cause and Effect**:
	+ The narrative explores the cause-and-effect relationships between the Ice-Glutton Giant's actions and the crystals' responses, helping students understand these interactions.
* **Systems and System Models**:
	+ The interconnected story involving different celestial bodies can help illustrate the concept of systems and their interactions.
* **Structure and Function**:
	+ Understanding how the structure of different crystals determines their function and properties.

NGSS Next Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The exploration of crystal structures, including gypsum and diamonds, supports this performance expectation.
* **MS-ESS1-3**: Analyze and interpret data to determine scale properties of objects in the Solar System.
	+ The interactions between crystals from Jupiter and Earth align with understanding the scale and properties of objects in the Solar System.

 NGSSSNext Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.4**: Classify and compare substances based on characteristic physical properties.
	+ The book’s discussion on the properties of different crystal types fits this standard.
* **SC.912.E.5.3**: Describe and identify patterns in the organization of systems at different scales using models.
	+ The narrative involving the interactions of crystals from different celestial bodies aligns with this standard.

Application in Curriculum

* **Middle School Science Curriculum**: Teachers can use Book 28 to introduce and reinforce concepts related to crystal structures, their properties, and their significance in Earth and space sciences. It can be integrated into physical science, chemistry, and astronomy lessons.
* **High School Science Curriculum**: The book can serve as a supplementary resource to deepen students' understanding of crystallinity and the physical interactions between materials in our Solar System.

By aligning Tom the Atom Book 28 with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom-the-Atom, Book 29: The salty war! Part IV.**

It is a fascinating fable in the world of atoms. All diamonds from Jupiter "cook" a plan to hinder the evil Ice-Glutton Giant. Planet Earth is their next stop. King Naicu, the king of Naica Mines --and a friend of Blackie diamond from Jupiter-- help Jupiter's diamonds to accomplish the plan. The whales in Guerrero Negro take care of the rest! You will learn about the type of crystals found in the fascinating mine of Naica. You will also learn some interesting facts about salt (Na-Cl).

### **Learning Objectives** (New Concepts Books 23-31: After this lesson, students will review the concepts learned on . Salt crystals and their effect on human health and salt mines)

Framework for K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ The book's focus on the properties of crystals and salt aligns with understanding the structure and properties of matter.
* **ESS1.B: Earth and the Solar System**:
	+ By discussing the interaction between crystals from Jupiter and those on Earth, the book fits within the broader context of understanding Earth's place in the Solar System.

##### **Crosscutting Concepts:**

* **Patterns**:
	+ Recognizing patterns in the structure and formation of crystals.
* **Cause and Effect**:
	+ Exploring the effects of interactions between diverse types of crystals and their environments.
* **Systems and System Models**:
	+ The interconnected story involving different celestial bodies illustrates the concept of systems and their interactions.

 NGSSNext Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The book’s exploration of crystal structures, including salt and minerals from the Naica mine, supports this performance expectation.
* **MS-ESS1-3**: Analyze and interpret data to determine scale properties of objects in the Solar System.
	+ The interactions between crystals from Jupiter and Earth align with understanding the scale and properties of objects in the Solar System.

 NGSSSNext Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.4**: Classify and compare substances based on characteristic physical properties.
	+ The book’s discussion on the properties of crystals and salt fits this standard.
* **SC.912.E.5.3**: Describe and identify patterns in the organization of systems at different scales using models.
	+ The narrative involving the interactions of crystals from different celestial bodies aligns with this standard.

Application in Curriculum

* **Middle School Science Curriculum**: Teachers can use Book 29 to introduce and reinforce concepts related to crystal structures, their properties, and their significance in both Earth and space sciences. It can be integrated into physical science, chemistry, and astronomy lessons.
* **High School Science Curriculum**: The book can serve as a supplementary resource to deepen students' understanding of crystallinity and the physical interactions between materials in our Solar System.

By aligning Tom the Atom Book 29 with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom the Atom, Book 30: The desert sky has a million eyes between the canyon and the sky, and the stars are on our side! Part V.**

What was an unsolvable problem on Jupiter ended very well, leaving behind Guerrero Negro, the evil giant Ice-Glutton! The four parts of history become a learning adventure and existence saver for the crystals of the Universe! Earth's large size and multicolor crystals help to deactivate the menace of the Ice-Glutton Giant, who was eating and disseminating all Jupiter's diamonds. Jupiter Diamond enjoys an exciting visit to a museum in the Copper Canyon on Earth. Now, the crystal of Jupiter goes safe and happy back home.

### **Learning Objectives** (New Concepts Books 23-30: After this lesson, students will review the concepts learned on. Mineral division by chemical composition. Mohs Scale for Crystals)

Frameworkfor K-12 Science Education

* **PS1.A: Structure and Properties of Matter**:
	+ The book's emphasis on the properties and characteristics of multicolor crystals aligns with understanding the structure and properties of matter.
* **ESS1.B: Earth and the Solar System**:
	+ The interactions between crystals from Jupiter and those on Earth, as well as the exploration of Earth's geology and mineralogy, fit within the broader context of understanding Earth's place in the Solar System.

##### **Crosscutting Concepts:**

* **Cause and Effect**:
	+ The book explores cause-and-effect relationships between the Ice-Glutton Giant's actions and the crystals' responses, helping students understand these interactions.
* **Systems and System Models**:
	+ The interconnected narrative involving different celestial bodies and their crystals illustrates the concept of systems and their interactions.
* **Stability and Change**:
	+ Understanding how the crystals restore stability by overcoming the threat of the Ice-Glutton Giant ties into the concept of stability and change.

 **NGSS** Next Generation Science Standards

* **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
	+ The exploration of crystal structures, including the properties of multicolor crystals, supports this performance expectation.
* **MS-ESS1-3**: Analyze and interpret data to determine scale properties of objects in the Solar System.
	+ The interactions between crystals from Jupiter and Earth align with understanding the scale and properties of objects in the Solar System.

 **NGSSS** Next Generation Sunshine State Standards (and six additional States)

* **SC.8.P.8.4**: Classify and compare substances based on characteristic physical properties.
	+ The book’s discussion on the properties of different crystal types fits this standard.
* **SC.912.E.5.3**: Describe and identify patterns in the organization of systems at different scales using models.
	+ The narrative involving the interactions of crystals from different celestial bodies aligns with this standard.

**Application in Curriculum**

* **Middle School Science Curriculum**: Teachers can use Book 30 to introduce and reinforce concepts related to crystal structures, their properties, and their significance in both Earth and space sciences. It can be integrated into physical science, chemistry, and astronomy lessons.
* **High School Science Curriculum**: The book can serve as a supplementary resource to deepen students' understanding of crystallinity and the physical interactions between materials in our Solar System.

By aligning Tom the Atom Book 30 with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

**Tom the Atom, Book 31: I survive on meteorites, asteroids, rocks, granite, and remedial rights! Part VI.**

The Book contains a brief review of what you learned. It expands on the differences between asteroids (Meteoroids and Meteorites) and Comets (Dirty ice). You will learn about deadly poisonous terrestrial crystals and minerals, which you want to know if you like crystals and have a crystal collection!

### **Learning Objectives** (Review of concepts learned in Books 23-30 and two new concepts explained. After this lesson, students will review the concepts learned on. Meteror meteorites. poisonous crystals)

Frameworkfor K-12 Science Education

* **ESS1.B: Earth and the Solar System**:
	+ The book's focus on asteroids, meteoroids, meteorites, and comets aligns with understanding the structure and components of our Solar System.
* **PS1.A: Structure and Properties of Matter**:
	+ The discussion on the properties of poisonous terrestrial crystals and minerals fits within the understanding of matter's structure and properties.

##### **Crosscutting Concepts:**

* **Patterns**:
	+ Recognizing patterns in the composition and characteristics of celestial bodies and minerals.
* **Cause and Effect**:
	+ Exploring the cause-and-effect relationships between the composition of celestial bodies and their impact on Earth.
* **Structure and Function**:
	+ Understanding how the structure of different minerals and crystals determines their properties and potential toxicity.

**NGSS** Next Generation Science Standards

* **MS-ESS1-2**: Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
	+ The book's exploration of asteroids, meteoroids, meteorites, and comets supports this performance expectation.
* **MS-ESS1-3**: Analyze and interpret data to determine scale properties of objects in the Solar System.
	+ The differentiation between various celestial bodies aligns with understanding the scale and properties of objects in the Solar System.
* **HS-PS1-1**: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
	+ The book's discussion on the chemical composition of poisonous terrestrial crystals and minerals aligns with this performance expectation.

 **NGSSS** Next Generation Sunshine State Standards (and six additional States)

* **SC.8.E.5.4**: Explore the law of universal gravitation by explaining gravity's role in forming planets, stars, and solar systems and determining their motions.
	+ The book’s content on celestial bodies aligns with this standard.
* **SC.8.P.8.4**: Classify and compare substances based on characteristic physical properties.
	+ The book’s discussion on terrestrial crystals and minerals' properties fits this standard.
* **SC.912.E.5.3**: Describe and identify patterns in the organization of systems at different scales using models.
	+ The differentiation between various celestial bodies aligns with this standard.

**Application in Curriculum**

* **Middle School Science Curriculum**: Teachers can use Book 31 to introduce and reinforce concepts related to celestial bodies, their properties, and their interactions with Earth. It can be integrated into lessons on Earth and space sciences.
* **High School Science Curriculum**: The book can serve as a supplementary resource to deepen students' understanding of the structure and properties of matter, mainly focusing on poisonous terrestrial crystals and minerals.

By aligning Tom the Atom Book 31 with these standards, educators can effectively teach critical scientific concepts while keeping students engaged with an imaginative and relatable narrative.

## **EXAMPLE**

Using Copilot of Microsoft and the summarized description for each book, you can type “more detailed information on integrating this book into a specific curriculum or lesson plan.”

Let's discuss integrating Tom the Atom, Book 31, into a specific curriculum or lesson plan for middle and high school science classes.

**Integrating Tom the Atom, Book 31 in Middle School Science Curriculum**

**Key Concepts:**

* Differences between asteroids, meteoroids, meteorites, and comets.
* Properties and formation of poisonous terrestrial crystals and minerals.
* The role of these celestial bodies and minerals in Earth's geology and the broader Solar System.

**Lesson Plan Outline:**

1. **Introduction (10 minutes)**:
	* Begin with a brief review of the previous books in the series to set the context.
	* Introduce the main themes of Book 31 and explain the learning objectives.
2. **Reading and Discussion (20 minutes)**:
	* Read selected excerpts from Book 31 that explain the differences between celestial bodies and the properties of crystals and minerals.
	* Facilitate a classroom discussion about these concepts. Use guiding questions like:
		+ What are the key differences between asteroids, meteoroids, meteorites, and comets?
		+ Why are some terrestrial crystals and minerals considered poisonous?
3. **Interactive Activity (20 minutes)**:
	* Conduct an interactive activity where students use craft materials to create models of different celestial bodies.
	* Have students research and present on a specific poisonous mineral, explaining its properties and uses.
4. **Wrap-Up and Review (10 minutes)**:
	* Summarize the key points covered in the lesson.
	* Assign a short reflection or worksheet for homework where students describe the impact of a specific celestial body or mineral on Earth.

**Integrating Tom the Atom, Book 31 in High School Science Curriculum**

**Key Concepts:**

* In-depth understanding of celestial bodies and their interactions with Earth.
* Detailed study of terrestrial crystals and minerals' structure, properties, and toxicity.

**Lesson Plan Outline:**

1. **Introduction (10 minutes)**:
	* Provide an overview of the main themes and objectives of Book 31.
	* Discuss how these concepts fit into the broader study of Earth and space sciences.
2. **In-Depth Reading and Analysis (30 minutes)**:
	* Read and analyze selected excerpts from Book 31.
	* Facilitate a detailed discussion on the scientific principles behind the formation and properties of celestial bodies and poisonous minerals.
3. **Research Project (30 minutes)**:
	* Assign students to small groups to research a specific celestial body or mineral.
	* Have each group present their findings, focusing on their topic's scientific, environmental, and health implications.
4. **Laboratory Activity (30 minutes)**:
	* Conduct a laboratory activity where students examine samples of minerals and identify their properties.
	* Include a safety discussion on handling potentially hazardous materials.
5. **Wrap-Up and Assessment (20 minutes)**:
	* Review the key concepts covered in the lesson.
	* Administer a short quiz or assessment to gauge students' understanding of the material.

By following these outlines, educators can effectively integrate **Tom the Atom, Book 31,** into their science curriculum, providing students with a comprehensive understanding of celestial and terrestrial phenomena.

Furthermore, a teacher or parent would like to explore specific activities or resources for these lesson plans:

Here are some specific activities and resources to help you integrate **Tom the Atom, Book 31,** into your middle and high school science lesson plans.

**Middle School Science Curriculum**

**Activity 1: Celestial Bodies Model Creation**

* **Objective**: Students will create models of asteroids, meteoroids, meteorites, and comets using craft materials.
* **Materials**: Clay, styrofoam balls, paint, markers, and other craft supplies.
* **Instructions**:
	1. Divide students into small groups and assign each group a different celestial body.
	2. Provide materials and guide students in creating their models.
	3. Have each group present their model and explain the characteristics and differences between their celestial body and others.

**Activity 2: Mineral Research and Presentation**

* **Objective**: Students will research poisonous terrestrial crystals and minerals and present their findings.
* **Instructions**:
	1. Assign each student or group a different poisonous mineral to research.
	2. Provide research questions to guide their investigation, such as: What are the properties of this mineral? Why is it considered poisonous? Where is it found?
	3. Students create a poster or digital presentation to share their findings with the class.

**Resource: Interactive Websites**

* **NASA's Solar System Exploration**: This site offers detailed information about celestial bodies in our solar system. NASA Solar System Exploration
* **Mineralogy Database**: A resource for researching minerals, including their properties and uses.

**High School Science Curriculum**

**Activity 1: Lab Investigation - Mineral Identification**

* **Objective**: Students will examine mineral samples and identify their properties.
* **Materials**: Mineral samples, hand lenses, streak plates, hardness kits, and reference guides.
* **Instructions**:
	1. Provide each student or group with a set of mineral samples.
	2. Have students use the provided tools to evaluate and record properties such as color, streak, hardness, and luster.
	3. Students compare their findings to a reference guide to identify each mineral and note any potentially poisonous properties.

**Activity 2: Research Project - Celestial Bodies and Their Impact**

* **Objective**: Students will research the impact of asteroids, meteoroids, meteorites, and comets on Earth.
* **Instructions**:
	1. Divide students into small groups and assign each group a different celestial body.
	2. Provide research questions to guide their investigation, such as: How do these celestial bodies form? What is their impact on Earth? Are there any historical events related to these bodies?
	3. Students create a detailed report or presentation to share their findings with the class.

**Resource: Scientific Databases**

* **National Center for Science Education (NCSE)**: Provides resources and information on various scientific topics, including Earth and space sciences. NCSE
* **The Mineralogical Society of America (MSA)**: Offers resources and publications on mineralogy. Mineralogical Society of America

By incorporating these activities and resources into your lesson plans, you can provide students with hands-on, engaging learning experiences that deepen their understanding of the concepts covered in **Tom the Atom, Book 31**.

Feel free to ask if you need more detailed lesson plans or additional resources!

Similar help can be found using the book description that fits the Standard and curriculum to teach for each State and using Copilot.

## HISTORICAL DEVELOPMENT OF STANDARDS AND CURRICULA

Several people make the mistake of assuming that standards and curriculum are the same thing. They aren’t, and it is essential to understand the difference to implement the state standards successfully.

Standards tell us the minimum expectations of what students can demonstrate as a result of classroom instruction, but they do not tell us how students are to learn it. That is the job of the curriculum. Curriculum is the day-to-day outline of teachers' strategies to help students learn. It involves textbooks, homework assignments, classroom activities, and assessments—the “how” of teaching.

**US:**

In the last century, the United States did not have the same standards in all 50 states. Each state has its standards. A general effort across all 50 states had been developing across the United States. This is a brief and recent summary of important events that have happened.

**1983**

Standards-based education reform in the United States began officially with the publication of *A Nation at Risk* in 1983.

**1989**

In 1989, an education summit involving all fifty state governors and President George H. W. Bush resulted in the adoption of national education goals for the year 2000, including content standards. That same year, the National Council of Teachers of Mathematics published the *Curriculum and Evaluation Standards for School Mathematics*, a standards-based document.

**1990**

By the 1990 National Education Summit, 44 governors and 50 corporate CEOs set the priorities for children's education (Achieve, 1998). A reauthorization of the Elementary and Secondary Education Act (ESEA) was passed to ensure that all states had rigorous standards for all subject areas and grade levels.

The National Science Foundation conceived the notion of STEM (Science, technology, engineering, and mathematics ) in the late 1990s in the US. Several international organizations pay significant attention to STEM issues, maintaining a global focus. Science, technology, engineering, and mathematics (STEM) is an umbrella term that groups the distinct but related technical disciplines of science, technology, engineering, and mathematics. The term is typically used in the context of education policy. A standards-based vision was enacted by the Clinton Administration in 1994.

**2000**

The Bush Administration then carried forward this vision. In 2001, with the passing of “No Child Left Behind (NCLB).” 2002 President Bush signed the bipartisan No Child Left Behind Act (NCLB).

**2010**

The concern to bring science, technology, engineering, and mathematics to kindergarten until the rewrite of the curriculum standards in high school culminated with the publication of a report in 2013. The writing of the standards themselves was up to the 40-member writing team from a group of 26 states. The actual development of the NGSS standards was essentially a state-led effort along with the National Research Council (NRC), the National Science Teachers Association (NSTA), and the American Association for the Advancement of Science (AAAS), among others.

In addition to the committee working on the Next Generation Science Standards, the NRC worked with four education design teams in physical science, life science, earth/space science, and engineering. These design teams collaborated with the committee and created K-12 frameworks for each discipline. The team developed a Framework using the most current science and science learning research and released a draft to the public in July 2010. It outlines what a student in each primary and secondary education grade should know in life science, earth science, physical science, and engineering. In 2011, a team of scientists and educators working on the Next Generation Science Standards came from all over the United States. The Next Generation Science Standards (NGSS) became available when they were completed in April of 2013 and are currently formally adopted in 16 states. The NGSS guidelines are research-based K–12 science content standards that aim to improve science education for all students. These Next Generation learning standards are a critical component in many STEM curriculums.

**2015**

Article 10th of the US Constitution considers that the decision on education matters belongs to the states, not the Federal Government. The “Every Student Succeeds Act (ESSA)” is the education policy or law that replaced the “No Child Left Behind Act (NCLB)” in 2015. The purpose of the ESSA is to provide high-quality education to all students. It shifts decision-making from a**federal to a state level, giving states more flexibility.** The law also aims to strengthen federal government support of science, technology, engineering, and mathematics (STEM) education, adding new federal funding streams for STEM education and establishing the STEM Master Teacher Corps, a new leadership and professional development program.

**Present Time**

The National Research Council (NRC) defines disciplinary core ideas as focusing on the K–12 science curriculum, instruction, and assessments of the most critical aspects of science disciplinary content knowledge. To identify the relevant core ideas for K–12 level science, the NRC [*Framework*](http://sites.nationalacademies.org/dbasse/bose/framework_k12_science/index.htm) Committee developed and applied a set of criteria.  To be considered "core," the ideas had to meet at least two of the following criteria and ideally all four: Have broad importance across multiple sciences or engineering disciplines or be a key organizing principle of a single discipline; Provide a key tool for understanding or investigating more complex ideas and solving problems; Relate to the interests and life experiences of students or be connected to societal or personal concerns that require scientific or technological knowledge; Be teachable and learnable over multiple grades at increasing levels of depth and sophistication.

The federal government was not involved in the effort to develop the Next Generation Science Standards (NGSS). It was state-led, and states are deciding whether or not to adopt the NGSS. The work undertaken by both the National Research Council (NRC) and Achieve has been supported by the Carnegie Corporation of New York.  No federal funds were used to develop the standards.

**What is the difference between the Common Core State Standards for Literacy in Science and the NGSS?**

The Common Core State Standards (CCSS) for Literacy were written to help students meet the particular challenges of reading, writing, speaking, listening, and language in their respective fields—in this case, science. The literacy standards do not replace science standards but supplement them. The NGSS lays out the disciplinary core ideas, science and engineering practices, and crosscutting concepts that students should master in preparation for college and careers.

The Next Generation Science Standards (NGSS) were developed by 20 states in partnership with the National Science Teachers Association, the National Research Council, the American Association for the Advancement of Science, and Achieve, a nonprofit organization that develops resources to prepare students for college and careers.

A total of 24 states have chosen to use NRC research in this manner. Some states have done so, including Arizona, Louisiana, Massachusetts, and New York.

The remaining six states (Florida, North Carolina, Ohio, Pennsylvania, Texas, and Virginia) have not adopted any form of NGSS or NRC-based standards for science education.

The 50 states in the US have adopted three primary types of standards/curricula:

1. **NGSS (Next Generation Science Standards)**:
	* **Focus**: Science education for K-12 students.
	* **Structure**: Emphasizes three dimensions: disciplinary core ideas, science and engineering practices, and crosscutting concepts.
	* **Adoption**: Developed by a consortium of states and organizations and adopted by many states across the U.S.
2. **Framework**:
	* **Focus**: General guidelines for educational course design and curriculum development.
	* **Structure**: Provides a conceptual map for planning or revising courses, aligning learning goals with classroom activities, and integrating assessment into learning.
	* **Examples**: Teaching and learning frameworks like Backward Design, which starts with desired end goals and plans backward to create learning experiences.
3. **Florida type of Standards**:
	* **Focus**: Comprehensive standards for K-12 education in Florida, including science, mathematics, English language arts, and social studies.
	* **Structure**: Specific to Florida's educational requirements and assessments.
	* **Adoption**: Developed and adopted by the Florida Department of Education.

2023 still does not have precisely the same guidelines from the NGSS, nor has it openly adopted the STEM program to implement their guidelines (NGSS or others) in the curriculum. However, the differences in procedures and the adoption of STEM or similar educational tools to fulfill their policies are closing. We observe that all states acknowledge the importance of introducing concepts of science, technology, engineering, and mathematics to students from an early age in all grades from K to 12.

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