Grades 6-12 Science Curriculum Analysis Worksheet

Current research on science education emphasizes the importance of integrating the learning progressions from all three dimensions included in *A Framework for K-12 Science Education.* This Curriculum Analysis Worksheet is a tool that can be used to align your current instructional practices to a 3-dimensional model of instruction, designed to deepen student learning.

1.	Identify a science concept or concepts within the Arizona Science Standard from Strands 4, 5, or 6 that you teach at your grade level/course. Fill in the title of the science concept at the top of the worksheet.
2.	Identify learning progressions from each of the three dimensions that will be bundled together to build student conceptual understanding of the science concept(s) selected in Step 1.
3.	a. Identify objectives from the Arizona Science Standard from Strands 1, 2 and 3 that align with the **Science and Engineering Practices** learning progression(s) you have identified in Step 2. b. Examine your current science curriculum to identify ways you can modify instruction to reach the vision of *A Framework for K-12 Science Education* while you currently teach grade level objectives aligned to the Arizona Science Standard.
4.	a. Identify the current objectives from the Arizona Science Standard from Strands 4, 5, and 6 that align with the **Disciplinary Core Ideas** learning progression(s) you have identified in Step 2. b. Examine your current science curriculum to identify ways you can modify instruction to reach the vision of *A Framework for K-12 Science Education* while you currently teach grade level objectives aligned to the Arizona Science Standard.
5.	a. Identify the current unifying concept(s) from page viii of the Arizona Science Standard that aligns with the **Crosscutting Concepts** learning progression(s) you have identified in Step 2. b. Examine your current science curriculum to identify ways you can modify instruction to reach the vision of *A Framework for K-12 Science Education* while you currently teach grade level objectives aligned to the Arizona Science Standard.
6.	a. Identify connections to grade level ELA/Literacy standards, as appropriate. b. Identify connections to grade level Mathematics standards and practices, as appropriate.

1. Arizona Science Concept: Strand 5 Concept 1: Properties and Changes of Properties in Matter

Big Idea/Scientific Phenomenon: All matter in the Universe is made of very small particles.

- Substances combine (react chemically) with other substances to form new substances with different properties, yet matter is conserved.

2. Science and Engineering Practices Learning Progression *(See Learning Progressions for 6-12 Science)* **Analyzing and Interpreting Data** • Analyze and interpret data to determine similarities and differences in findings. • Analyze and interpret data to provide evidence for phenomena. **Developing and Using Models** • Develop a model to predict and/or describe phenomena. • Develop a model to describe unobservable mechanisms.	**Disciplinary Core Ideas Learning Progression** *(See Learning Progressions for 6-12 Science)* **PS1: Matter and Its Interactions** • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. • The total number of each type of atom is conserved, and thus the mass does not change.	**Crosscutting Concepts Learning Progression** *(See Learning Progressions for 6-12 Science)* **Energy and Matter** • Matter is conserved because atoms are conserved in physical and chemical processes.(**Patterns** • Macroscopic patterns are related to the nature of microscopic and atomic-level structure.

Three Dimensional Learning Outcomes:

- Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occ
- Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

3. Science and Engineering Practices

Current Practice

Identify performance objectives from Strands 1-3 within the Arizona Science Standard that align to the learning progressions listed above.
(Strand 1: Inquiry; Strand 2: History and Nature of Science; Strand 3: Science and Social Perspectives)

Strand 1 Concept 2: Scientific Testing (Investigating and Modeling)

PO 1. Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry.

PO 4. Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers).

PO 5. Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs.

Strand 1 Concept 3: Analysis and Conclusions

PO 2. Form a logical argument about a correlation between variables or sequence of events (e.g., construct a cause-and-effect chain that explains a sequence of events).

PO 5. Explain how evidence supports the validity and reliability of a conclusion.

Strand 1 Concept 4: Communication

PO 1. Communicate the results of an investigation.

PO 3. Present analyses and conclusions in clear, concise formats.

PO 5. Communicate the results and conclusion of the investigation.

Vision of A Framework for K-12 Science Education

Gap Analysis/Curriculum Examination
Refer to the Science and Engineering practice learning progressions within the Learning Progressions for 6-12 Science document and your current curriculum to answer the following questions.

- What practices are currently missing from my curriculum?
- What changes and refinements need to be made?
- What strategies/investigations can be implemented to achieve the vision?

Engage:

1. Show students a demo where a liquid (vinegar) is combined with a solid (baking soda).
2. Ask students to describe what they observed.
3. Pose the following questions for students to investigate:
   - What are the properties of each reactant?
   - What happened to the reactants when the two are combined in a bottle?
   - What happens to the molecules and atoms as the reaction occurs?
   - What are the properties of the product?
   - Is the mass the same before and after the reaction?

Explore:

1. Students research and/or measure physical properties (states, density, boiling point, solubility, etc.) and chemical properties (pH, reactivity, etc.) of each reactant.
2. Students plan and conduct an experiment to collect data on the chemical reaction between baking soda and vinegar (can add baking soda to a balloon and vinegar to a bottle, and then combine). Mass of all reactants and products should be recorded.
3. Students research and/or measure physical properties (states, density, boiling point, solubility, etc.) and chemical properties (pH, reactivity, etc.) of the product.

Explain:

1. Using the observations and data collected; create an evidence based explanation (Claims-Evidence-Reasoning) about this chemical reaction and conservation of mass.

Extend:

1. Develop a model that can be used to predict outcomes (changes in chemical or physical properties, conservation of matter) in other chemical reactions.

4. Disciplinary Core Ideas

Current Performance Objectives

Strand 5 Concept 1: Properties and Changes of Properties in Matter

PO 1. Identify different kinds of matter based on the following physical properties:

- states
- density
- boiling point
- melting point
- solubility

PO 2. Identify different kinds of matter based on the following chemical properties:

- reactivity
- pH
- oxidation (corrosion)

PO 3. Identify the following types of evidence that a chemical reaction has occurred:

- formation of a precipitate
- generation of gas
- color change
- absorption or release of heat

PO 4. Classify matter in terms of elements, compounds~~, or mixtures~~.

Vision of A Framework for K-12 Science Education

Gap Analysis

Refer to the Content learning progressions within the Learning Progressions for 6-12 Science document and your current curriculum to answer the following questions.

- What core idea(s) is/are currently targeted within my current curriculum?
- What changes and refinements need to be made? (add, refine, delete concepts)
- What strategies/investigations can be implemented to achieve the vision?

1. Discuss the safety and organization of all lab materials.
2. Provide an opportunity for students to make observations (chemical and physical properties) about several different substances before the substances undergo a chemical reaction. Have them record observation and include relevant data from substance cards. Cards should indicate the physical and chemical properties of the substances (ex. density, state at room temp, reactivity, pH), chemical formula and any other interesting facts for students to review.
3. Show students examples of several chemical reaction demos or videos and have them look for patterns of what happens during the reactions. Try to include demos or videos showing gas production, formation of precipitate, and color changes.
4. Students develop a list of evidence that demonstrates a chemical reaction has occurred and post in the classroom.
5. Have students create a model of the atoms and molecules involved in a simple chemical reaction.
   Ex. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_20$ or $NaOH + HCl \rightarrow NaCl + H_2O$
   Include in the model:
   - the idea that each molecule of the reactant or product is the same (ex. CO_2.)
   - when a chemical reaction occurs the atoms that make up the reactants rearrange and form new molecules
   - the number and type of atoms in the reactants is equal to the number and type of atoms in the products
   - each atom has a specific mass, which is the same for all atoms of that type
6. Have students present their models to the class.
7. Conduct the baking soda and vinegar in a bottle reaction. Have students create their procedures and remind them they must record observations and data for the experiment.

5. Crosscutting Concepts			
Current Crosscutting Concepts	**Unifying Concepts and Processes (Crosscutting concepts)** **Listed in page viii of the front matter of the Arizona Science Standard, and explained in the National Science Education Standards (1995) pp. 115-119** Systems, Order, and Organization Evidence, Models, and Explanation	**Vision of *A Framework for K-12 Science Education***	**Gap Analysis** **Refer to the Crosscutting Concepts learning progressions within the Learning Progressions for 6-12 Science document and your current curriculum to answer the following questions.** • How is/are the crosscutting concept(s) made explicit within my current curriculum? • What changes and refinements need to be made? • What strategies/investigations can be implemented to achieve the vision? **Energy and Matter** • Provide opportunities for students to recognize that all matter is conserved because no new atoms are created only rearranged into different substances. • Provide opportunities for students to understand that energy flows in chemical reactions and how the transfer of energy can be tracked during a chemical reaction. **Patterns** • Provide opportunities to students to see the patterns that exist in chemical reactions including changes in physical and chemical properties of each substance before and after the interaction and how these substances are changed on an atomic level.

6. Connections

Other Content Area Standards

Identify other Content Area Standards that will build student understanding of this concept or phenomenon, especially those in ELA/Literacy and Mathematics/Practices.

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.
RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6–8 texts and topics.*
RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
RST.6-8.9 Compare and contrast the information gained from experiments, simulations, videos, or multimedia sources with that gained from reading a text on the same topic.
WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research.
SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
SL.8.3 Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced.

Connections to Instruction

Gap Analysis
Refer to the Other content standards that are being used as a connection to answer the following questions.

- How are the connected standards explicitly taught within my current curriculum?
- What changes and refinements need to be made?
- What strategies/investigations can be implemented to achieve the vision?

Reading

- Provide data cards on substances for students to read and evaluate for patterns.
- Express visually the process of a chemical reaction focused on the atomic level.

Writing

- Write and follow procedures for conducting the vinegar and baking soda reaction.
- Students write explanations to explain the chemical reaction between baking soda and vinegar.
- Display data collected in appropriate ways, and explain how the information provides evidence to support a claim.

Speaking and Listening

- Students present their model (including a claim, evidence and reasoning) of chemical reactions to the class.
- Students evaluate other models, identifying the soundness of the claims, evidence, and reasoning.