What I Know about the CA NGSS Standards… and How Sure I Am…

PENCIL FACTS…
INK FACTS…
IN-STONE FACTS…

The Conceptual Shifts of the CA NGSS Standards

SHIFTS:	EVIDENCE
1. Should reflect the interconnectedness of science as it is practiced and experienced in the real world	
2. Are student performance expectations, not curriculum	
3. Build coherently across K-12	
4. Focus on deeper understanding of content as well as application of content	
5. Science and engineering are integrated, K-12	
6. Designed to prepare students for college, careers and citizenship	
7. Are aligned with the Literacy and Math CA Standards	

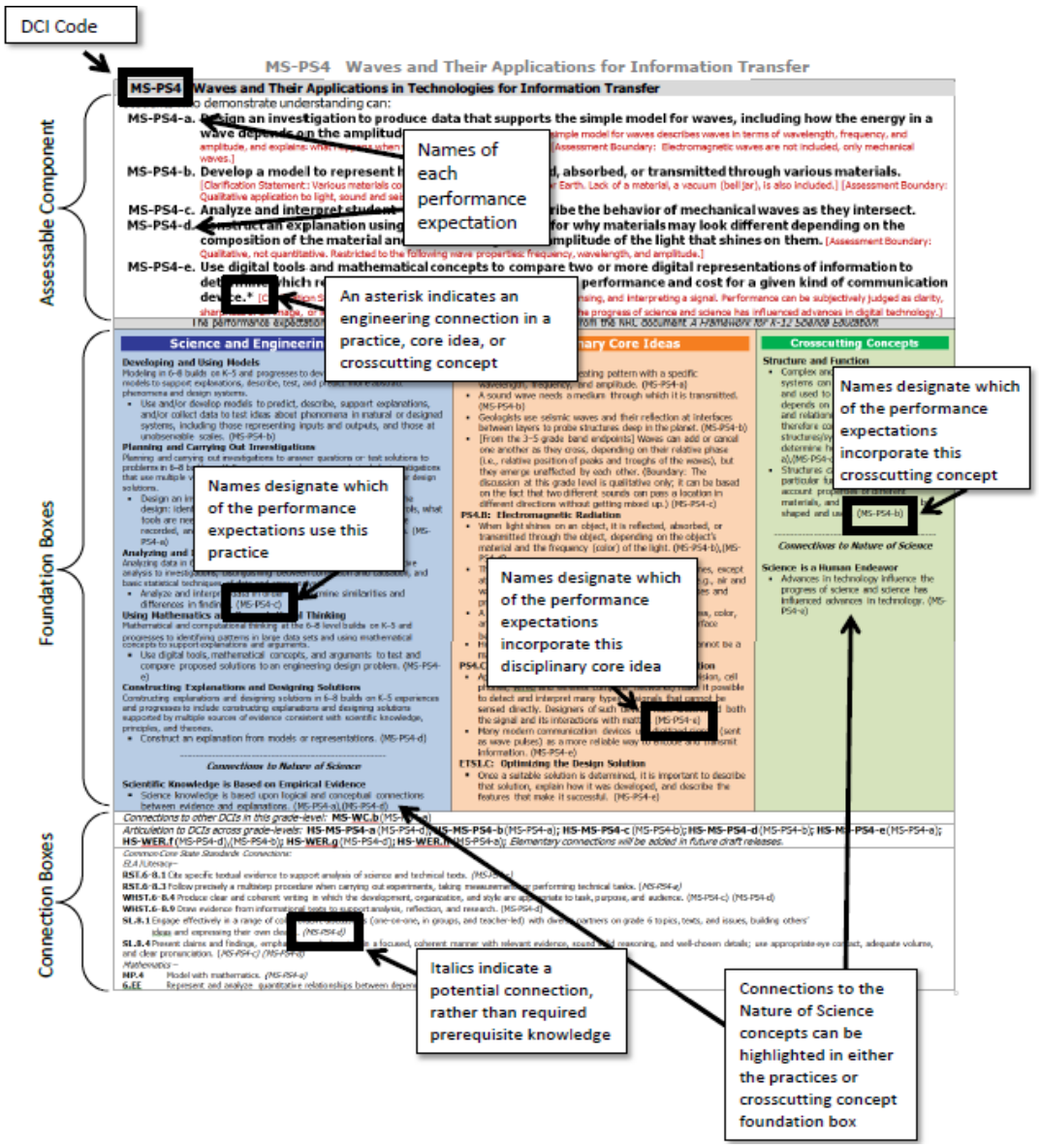
How to Read the *Next Generation Science Standards (NGSS)*

The Next Generation Science Standards (NGSS) are distinct from prior science standards in that they integrate three dimensions within each standard and have intentional connections across standards. To provide guidance and clarification to all users of the standards, the writers have created a System Architecture that highlights the NGSS as well as each of the three integral dimensions and connections to other grade bands and subjects. The standards are organized in a table with three main sections: 1) Performance expectation(s); 2) foundation boxes, and 3) connection boxes.

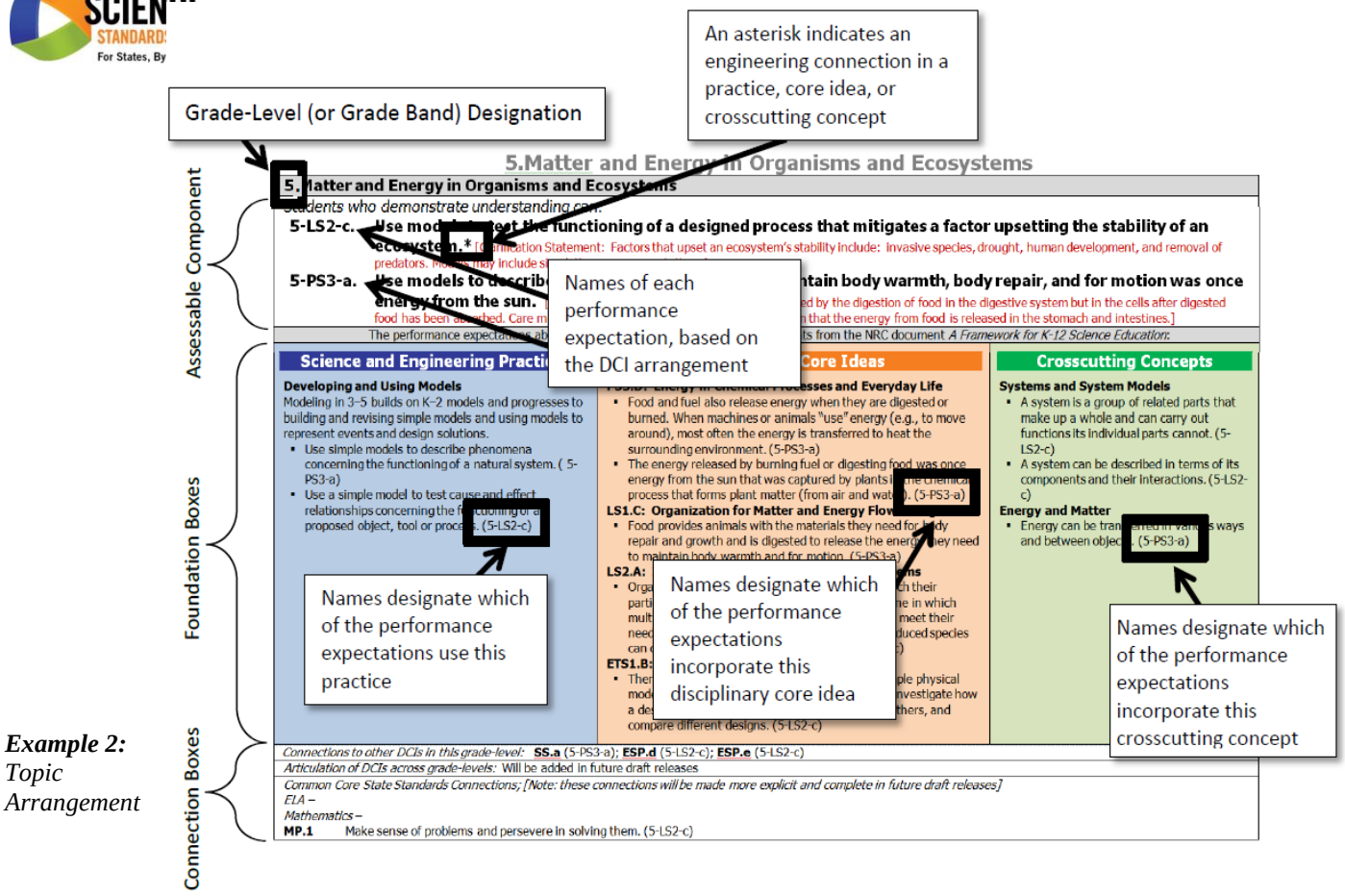
The NGSS represent a major shift in science education. As such, the lead states and writing teams wanted to ensure that the document represented that shift. To meet that goal, the document does not represent the traditional list of standards statements to be interpreted and "unpacked." The architecture is a departure from the norm for the purpose of giving all users as much information as possible to ensure common understanding of the standards. Given the different nature, this document was put together to guide new readers on the architecture and the relationships between the different components.

Reading the Elements of the System Architecture

In the figure below (Example 1), from top to bottom are seen the title, the topic label row, the performance expectation(s) (the assessable component), the foundation boxes (containing Practices, Disciplinary Core Ideas and Crosscutting Concepts), and the connection boxes. The coding is based on grade-level-DCI-PE. So, MS-PS4-a is translated to middle school, Waves and Their Applications for Information Transfer, first performance expectation.



Example 1: *DCI Coding and Arrangement*



Example 2: *Topic Arrangement*

A detailed explanation of the elements of the System Architecture follows:

Purpose of the Performance Expectations

The Next Generation Science Standards (NGSS) are written as student performance expectations, as recommended by *A Framework for K-12 Science Education,* blending Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. This is a key difference in the NGSS compared to most current state standards. The performance expectations are the assessable components of the NGSS architecture.

Successful student performance in the standards will require a deep understanding of each disciplinary core idea and all of the associated grade-band endpoints from the NRC *Framework*. The NGSS writers initially attempted to explicitly include all of these discreet, small-grain size components of the *Framework* in the performance expectations, but found that the resulting statements were bulky and reduced readers' comprehension of the standards. Instead, the performance expectations were written at a level necessary to communicate the "big idea" associated with each set of grade-band end points, showing the conceptual knowledge and skills students are to demonstrate.

It is important to note, however, that the performance expectations are not a set of instructional or assessment tasks. The writers intended the NGSS to be a set of student performances ***after*** instruction. Care has been taken to keep the level of each performance expectation at a conceptual level, leaving instructional procedures to states, districts, and teachers.

Some Key Points about the Performance Expectations

- The coding scheme is based on the disciplinary core idea arrangement as defined in *A Framework for K-12 Science Education*. Therefore, if the performance expectations are viewed in a different arrangement, by topic for instance, the coding is still representative of the disciplinary core ideas. The web application allows performance expectations to be searched by disciplinary core idea and topics.
- The performance expectations may also be viewed by topical groupings. Topical groupings of performance expectations do not imply a preferred ordering for instruction—nor should all performance expectations under one disciplinary core idea or topic necessarily be taught in one course. A list of all topics is included in the glossary.
- An asterisk (*) indicates engineering design performance expectations.
- There are two additional statements associated with the performance expectations that are meant to render additional support and clarity:
    - *Assessment Boundary Statements* are included with individual performance expectations where appropriate, to provide further guidance or to specify the scope of the expectation at a particular grade level.
    - *Clarification Statements* are designed to supply examples or additional clarification to the performance expectations.

Purpose of the Foundation Boxes

While the performance expectations can stand alone, a more coherent and complete view of what students should be able to do comes when the performance expectations are viewed in tandem with the foundation boxes. In many past science standards documents, conceptual level understanding requirements led to the exercise of "unpacking the standards." Conversely for the NGSS development process, the NRC *Framework* provided the "unpacked" information, which the NGSS writers used to develop the performance expectations. The writers then listed this source material from the *Framework* in the foundation boxes, thereby expanding and explaining the performance expectations in relation to the three dimensions: Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts. The goal of the foundation boxes is to provide enough information in order to not require the standards to be further "unpacked." While states will adopt the performance expectations as standards, the NGSS writing team sees the foundation boxes as essential to communicate the full, coherent picture to teachers and assessment/curriculum developers.

Each statement in any one of the three foundation boxes is coded to the performance expectation(s) that embody it in parentheses.

Origin of the Foundation Boxes

- *Science and Engineering Practice Statements*: These statements are derived from and grouped by the eight categories detailed in the *Framework* to further explain the science and engineering practices important to emphasize in each grade band. Most topical groupings of performance expectations emphasize only a few of the practice categories; however, all practices are emphasized within a grade band. Teachers should be encouraged to utilize several practices in any instruction. The purpose is to demonstrate the specific practice for which students will be held accountable.
- *Disciplinary Core Ideas (DCIs)*: These statements are taken verbatim from the *Framework*, and detail the sub supporting ideas necessary for student mastery of the core idea.
- *Crosscutting Concept Statements*: These statements were derived from the *Framework* to further explain the crosscutting concepts important to emphasize in each grade band. The

crosscutting concepts are grouped by the categories detailed in the *Framework*. Most topical groupings of performance expectations emphasize only a few of the crosscutting concept categories, however all are emphasized within a grade band. Again, the list is not exhaustive nor is it intended to limit instruction. Aspects of the Nature of Science are listed here. They are not additional content, but meant to show how the Nature of Science applies to specific performance expectations.

Purpose of the Connection Boxes

The Connection Boxes are designed to support a coherent vision of the standards. Due to the considerations of the next revision, the connections to DCI boxes will be finalized in the final release of the standards. The intent of each component is described below.

- *Connections to other DCIs in this grade level*: This box will contain the names of science topics in other disciplines that have corresponding disciplinary core ideas at the same grade level. For example, both Physical Science and Life Science standards contain core ideas related to Photosynthesis, and could be taught in relation to one another. As the standards move toward completion, this box will provide links to specific performance expectations.
- *Articulation of DCIs across grade levels*: This box will contain the names of other science topics that either 1) provide a foundation for student understanding of the core ideas in this standard (usually standards at prior grade levels) or 2) build on the foundation provided by the core ideas in this standard (usually standards at subsequent grade levels). As the standards move toward completion, this box will provide links to specific performance expectations.
- *Connections to the Common Core State Standards*: This box will contain the coding and names of pre-requisite or co-requisite Common Core State Standards in English Language Arts & and Literacy and Mathematics that align to the performance expectations. For example, performance expectations that require student use of exponential notation will align to the corresponding CCSS mathematics standards. An effort has been made to ensure, in particular with mathematics, that the skill needed by science was taught in a previous year where possible.

<u>Color Coding</u>

Online versions of the standards display color coding of the words within each standard statement. The colors represent the three dimensions: blue for Science and Engineering Practices, orange for Disciplinary Core Ideas, and green for Crosscutting Concepts. Clarification Statements and Assessment Boundaries are red. Because crosscutting concept connections usually incorporate some of the disciplinary core idea language in each performance expectation, it was not possible to color-code them both simultaneously.

Printed and PDF versions of the standards do not have color coding of the three dimensions; in these cases the coding for the three dimensions will be accomplished through the lowercase letters found after each foundation box statement.

EQuIP Rubric for Lessons & Units: Science

Lessons *and* units designed for the NGSS include clear and compelling evidence of the following*:*

I. NGSS 3D Design	II. NGSS Instructional Supports	III. Monitoring NGSS Student Progress
The lesson/unit is designed so students make sense of phenomena and/or design solutions to problems by engaging in student performances that integrate the three dimensions of the NGSS.	*The lesson/unit supports three-dimensional teaching and learning for ALL students by placing the lesson in a sequence of learning for all three dimensions and providing support for teachers to engage all students.*	*The lesson/unit supports monitoring student progress in all three dimensions of the NGSS as students make sense of phenomena and/or design solutions to problems.*
A. **Explaining Phenomena/Designing Solutions**: Making sense of phenomena and/or designing solutions to a problem drive student learning. i. Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving. ii. The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems. iii. When engineering is a learning focus, it is integrated with developing disciplinary core ideas from physical, life, and/or earth and space sciences. B. **Three Dimensions**: Builds understanding of multiple grade-appropriate elements of the science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) that are deliberately selected to aid student sense-making of phenomena and/or designing of solutions. i. Provides opportunities to *develop and use* specific elements of the SEP(s). ii. Provides opportunities to *develop and use* specific elements of the DCI(s). iii. Provides opportunities to *develop and use* specific elements of the CCC(s). C. **Integrating the Three Dimensions:** Student sense-making of phenomena and/or designing of solutions requires student performances that integrate elements of the SEPs, CCCs, and DCIs.	A. **Relevance and Authenticity**: Engages students in authentic and meaningful scenarios that reflect the practice of science and engineering as experienced in the real world. i. Students experience phenomena or design problems as directly as possible (firsthand or through media representations). ii. Includes suggestions for how to connect instruction to the students' home, neighborhood, community and/or culture as appropriate. iii. Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experience. B. **Student Ideas:** Provides opportunities for students to express, clarify, justify, interpret, and represent their ideas and to respond to peer and teacher feedback orally and/or in written form as appropriate. C. **Building Progressions**: Identifies and builds on students' prior learning in all three dimensions, including providing the following support to teachers: i. Explicitly identifying prior student learning expected for all three dimensions ii. Clearly explaining how the prior learning will be built upon D. **Scientific Accuracy**: Uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students' three-dimensional learning. E. **Differentiated Instruction**: Provides guidance for teachers to support differentiated instruction by including: i. Appropriate reading, writing, listening, and/or speaking alternatives (e.g., translations, picture support, graphic organizers, etc.) for students who are English language learners, have special needs, or read well below the grade level. ii. Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations. iii. Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.	A. **Monitoring 3D student performances**: Elicits direct, observable evidence of three-dimensional learning; students are using practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions. B. **Formative:** Embeds formative assessment processes throughout that evaluate student learning to inform instruction. C. **Scoring guidance**: Includes aligned rubrics and scoring guidelines that provide guidance for interpreting student performance along the three dimensions to support teachers in (a) planning instruction and (b) providing ongoing feedback to students. D. **Unbiased tasks/items**: Assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

EQuIP Rubric for Lessons & Units: Science

Units designed for the NGSS will *also include* clear and compelling evidence of the following additional criteria:

I. NGSS 3D Design	II. NGSS Instructional Supports	III. Monitoring NGSS Student Progress
D. **Unit Coherence**: Lessons fit together to target a set of performance expectations. i. Each lesson builds on prior lessons by addressing questions raised in those lessons, cultivating new questions that build on what students figured out, or cultivating new questions from related phenomena, problems, and prior student experiences. ii. The lessons help students develop toward proficiency in a targeted set of performance expectations. E. **Multiple Science Domains**: *When appropriate*, links are made across the science domains of life science, physical science and Earth and space science. i. Disciplinary core ideas from different disciplines are used together to explain phenomena. ii. The usefulness of crosscutting concepts to make sense of phenomena or design solutions to problems *across science domains* is highlighted. F. **Math and ELA:** Provides grade-appropriate connection(s) to the Common Core State Standards in Mathematics and/or English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects.	F. **Teacher Support for Unit Coherence:** Supports teachers in facilitating coherent student learning experiences over time by: i. Providing strategies for linking student engagement across lessons (e.g. cultivating new student questions at the end of a lesson in a way that leads to future lessons, helping students connect related problems and phenomena across lessons, etc.). ii. Providing strategies for ensuring student sense-making and/or problem-solving is linked to learning in all three dimensions. G. **Scaffolded differentiation over time**: Provides supports to help students engage in the practices as needed and gradually adjusts supports over time so that students are increasingly responsible for making sense of phenomena and/or designing solutions to problems.	E. **Coherent Assessment system:** Includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning. F. **Opportunity to learn**: Provides multiple opportunities for students to demonstrate performance of practices connected with their understanding of disciplinary core ideas and crosscutting concepts and receive feedback.

Hess' Cognitive Rigor Matrix & Curricular Examples: Applying Webb's Depth-of-Knowledge Levels to Bloom's Cognitive Process Dimensions – ***Math/Science***

Revised Bloom's Taxonomy	Webb's DOK Level 1 Recall & Reproduction	Webb's DOK Level 2 Skills & Concepts	Webb's DOK Level 3 Strategic Thinking/ Reasoning	Webb's DOK Level 4 Extended Thinking
Remember Retrieve knowledge from long-term memory, recognize, recall, locate, identify	o Recall, observe, & recognize facts, principles, properties o Recall/ identify conversions among representations or numbers (e.g., customary and metric measures)			
Understand Construct meaning, clarify, paraphrase, represent, translate, illustrate, give examples, classify, categorize, summarize, generalize, infer a logical conclusion (such as from examples given), predict, compare/contrast, match like ideas, explain, construct models	o Evaluate an expression o Locate points on a grid or number on number line o Solve a one-step problem o Represent math relationships in words, pictures, or symbols o Read, write, compare decimals in scientific notation	o Specify and explain relationships (e.g., non-examples/examples; cause-effect) o Make and record observations o Explain steps followed o Summarize results or concepts o Make basic inferences or logical predictions from data/observations o Use models /diagrams to represent or explain mathematical concepts o Make and explain estimates	o Use concepts to solve non-routine problems o Explain, generalize, or connect ideas using supporting evidence o Make and justify conjectures o Explain thinking when more than one response is possible o Explain phenomena in terms of concepts	o Relate mathematical or scientific concepts to other content areas, other domains, or other concepts o Develop generalizations of the results obtained and the strategies used (from investigation or readings) and apply them to new problem situations
Apply Carry out or use a procedure in a given situation; carry out (apply to a familiar task), or use (apply) to an unfamiliar task	o Follow simple procedures (recipe-type directions) o Calculate, measure, apply a rule (e.g., rounding) o Apply algorithm or formula (e.g., area, perimeter) o Solve linear equations o Make conversions among representations or numbers, or within and between customary and metric measures	o Select a procedure according to criteria and perform it o Solve routine problem applying multiple concepts or decision points o Retrieve information from a table, graph, or figure and use it solve a problem requiring multiple steps o Translate between tables, graphs, words, and symbolic notations (e.g., graph data from a table) o Construct models given criteria	o Design investigation for a specific purpose or research question o Conduct a designed investigation o Use concepts to solve non-routine problems o Use & show reasoning, planning, and evidence o Translate between problem & symbolic notation when not a direct translation	o Select or devise approach among many alternatives to solve a problem o Conduct a project that specifies a problem, identifies solution paths, solves the problem, and reports results
Analyze Break into constituent parts, determine how parts relate, differentiate between relevant-irrelevant, distinguish, focus, select, organize, outline, find coherence, deconstruct	o Retrieve information from a table or graph to answer a question o Identify whether specific information is contained in graphic representations (e.g., table, graph, T-chart, diagram) o Identify a pattern/trend	o Categorize, classify materials, data, figures based on characteristics o Organize or order data o Compare/ contrast figures or data o Select appropriate graph and organize & display data o Interpret data from a simple graph o Extend a pattern	o Compare information within or across data sets or texts o Analyze and draw conclusions from data, citing evidence o Generalize a pattern o Interpret data from complex graph o Analyze similarities/differences between procedures or solutions	o Analyze multiple sources of evidence o analyze complex/abstract themes o Gather, analyze, and evaluate information
Evaluate Make judgments based on criteria, check, detect inconsistencies or fallacies, judge, critique			o Cite evidence and develop a logical argument for concepts or solutions o Describe, compare, and contrast solution methods o Verify reasonableness of results	o Gather, analyze, & evaluate information to draw conclusions o Apply understanding in a novel way, provide argument or justification for the application
Create Reorganize elements into new patterns/structures, generate, hypothesize, design, plan, construct, produce	o Brainstorm ideas, concepts, or perspectives related to a topic	o Generate conjectures or hypotheses based on observations or prior knowledge and experience	o Synthesize information within one data set, source, or text o Formulate an original problem given a situation o Develop a scientific/mathematical model for a complex situation	o Synthesize information across multiple sources or texts o Design a mathematical model to inform and solve a practical or abstract situation

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