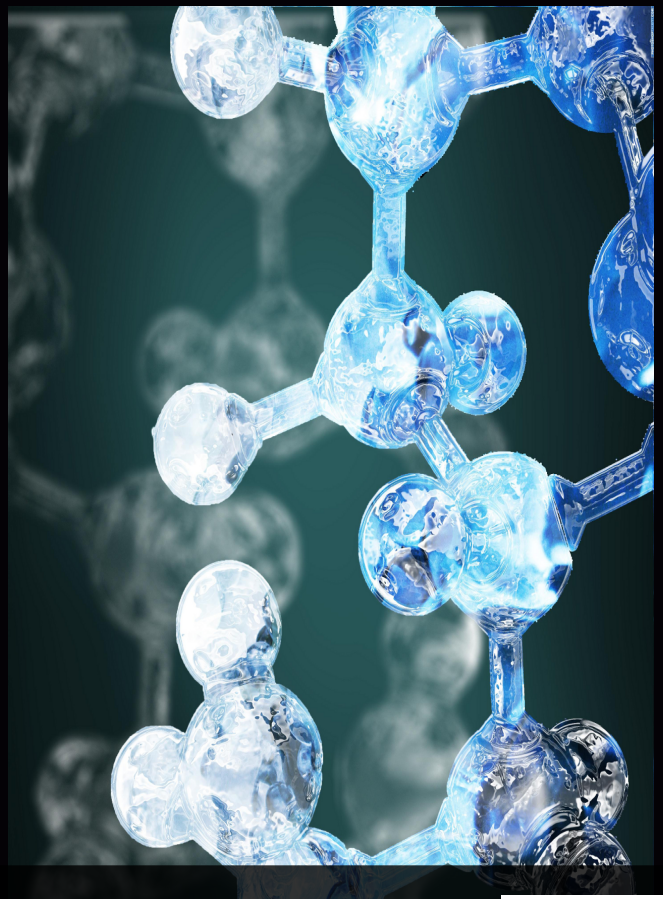
CHEMISTRY



Curriculum Map
2016-2017

CANYONS School District

Science Curriculum Maps
CANYONS SCHOOL DISTRICT
2016-2017

Curriculum Mapping Purpose

Canyons School District's curriculum maps are standards-based maps driven by the Utah Core Standards and implemented using materials adopted by the Canyons' Board of Education. The maps and materials are coordinated within feeder systems (i.e. vertically) and within grade-levels (i.e. horizontally). Student achievement is increased when both teachers and students know where they are going, why they are going there, and what is required of them to get there.

Curriculum Maps are a Tool For:

- ALIGNMENT: Provides support and coordination between concepts, skills, standards, curriculum, and assessments
- COMMUNICATION: Articulates expectations and learning goals for students
- PLANNING: Focuses instructional decisions and targets critical information for instructional tasks
- COLLABORATION: Promotes professionalism and fosters dialogue between colleagues about best practices pertaining to sequencing, unit emphasis and length, integration, and review strategies

These maps were collaboratively developed and refined by teacher committees using feedback from classroom teachers, achievement coaches, building administrators, and the office of Evidence-Based Learning. It is with much appreciation that we recognize the many educators that collaborated in the effort to provide these maps for the teachers and students of CSD. Specific individuals that have assisted in the writing and editing of this document include:

Vicky Ginsburg

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Sara Carlson

Milo Maughan

Carly Silva

Gretchen Carr

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Canyons School District Academic Framework to Support Effective Instruction

Multi-Tiered System of Supports (MTSS) for Academics and Behavior

RTI Multi-Tiered System of Support	(1) Providing high quality core instruction (and intervention) matched to students' needs	(2) using data over time (i.e. rate of learning, level of performance, fidelity of implementation)	(3) to make important educational decisions.
CANYONS School District **Student Achievement Principles**	• All CSD students and educators are part of ONE proactive educational system. • Evidence-based instruction and interventions are aligned with rigorous content standards.	• Data are used to guide instructional decisions, and allocate resources. • CSD educators use assessments that are reliable, valid, and connected to standards	• CSD educators problem solve collaboratively to meet student needs.
	• Culture centers around building positive relationships, setting high expectations, and committing to every student's success. • Ongoing, targeted, quality professional development and coaching supports effective instruction for ALL students. • Leadership at all levels is vital.		

Core Expectations for ALL Teachers in the Classrooms and Common Areas

Standards for Instruction	Evidence-based Instructional Priorities	Time Allocation for Instruction	Teacher Learning Data	Student Performance Data	Collaborative Problem Solving for Improvement
Standards clarify what we want students to learn and do.	Planning, instruction, and assessment techniques to increase student engagement and achievement.	School culture ensures that instructional time is maximized to increase student growth.	Teacher learning and professional growth fostered through public practice and ongoing feedback.	Student academic and behavioral performance is assessed using a variety of reliable and valid methods.	Use data to problem solve and make decisions
Curriculum maps with common pacing guides Instructional content aligned with the Utah Core Standards Scientifically research-based programs Standards-based grades and report cards Cognitive Rigor (Depth of Knowledge – DOK) International Society for Technology in Education Standards (ISTE) School-wide Positive Behavioral Interventions and Supports (PBIS) World-class Instructional Design and Assessment (WIDA) Federal and state requirements (IEP, 504, ELs)	Classroom Positive Behavioral Interventions and Supports (PBIS) Explicit Instruction (I, We, Y'all, You) Instructional Hierarchy: Acquisition, Automaticity, Application (AAA) Systematic Vocabulary Development Maximizing Opportunities to Respond (OTR) Feedback Cycle Scaffolded Instruction & Grouping (SIG) Structures	Master schedule takes into consideration the learning needs of the student population. Scheduling is ensured for: • Intervention and skill-based instruction • Special Education services • English Language Development (ELD) Classroom instructional time is prioritized for instruction of standards Individual and team planning time is used to intentionally increase the application of evidence-based instructional priorities and standards for instruction	Annual setting of goals and documentation of progress (e.g. CSIP, LANDTrust, CTESS) Supporting teacher growth Formalized protocols and checklists to monitor and support implementation Public practice applications: • Coaching cycles with peer coaches, teacher specialists, achievement coach, and/or new teacher coach • Instructional Professional Learning Communities (IPLCs) • Learning walkthroughs and targeted observations • Lesson Study • Video Analysis	Assessment practices: • Inform instruction • Provide feedback about learning to students, parents, and teachers • Build student efficacy • Monitor student achievement and behavioral growth • Celebrate teaching and learning successes Assessment Types: • Classroom Assessing • Teams and Schoolwide Assessment • Districtwide Standards-based Benchmarks • Comprehensive Assessments • Screening Assessments (DIBELS, SRI, SMI) • Specialized Assessments (WIDA, IDEA, eligibility assessment, Phonics surveys)	Problem solving process: identify, analyze, plan, and evaluate Early warning system for identification of risk (academic, behavior, and attendance) Timely and consistent review of relevant data by teams (e.g. BLT, IPLC, CST): • Evaluate effectiveness of academic and behavior instruction for all groups of students using valid and reliable data (student and teacher data) • Determine needs for academic and behavior intervention

Public Practice and Coaching Supports

INSTRUCTIONAL PRIORITIES

Techniques to Increase Student Achievement and Engagement

Classroom Positive Interventions & Supports (PBIS)

Effect Size: .52

Explicit Instruction (I do, We do, Y'all Do, You do)

Effect Size: .57

Instructional Hierarchy (Acquisition, Automaticity, Application)

Effect Size: .57

Systematic Vocabulary Development

Effect Size: .67

Maximizing Opportunities to Respond (OTR)

Effect Size: .60

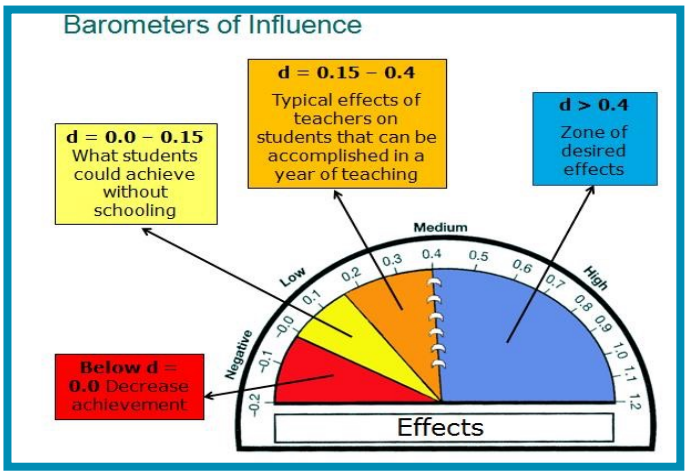
Feedback Cycle

Effect Size: .75

Scaffolded Instruction & Grouping

Effect Size: .49

Our time with students is limited and valuable. Every minute we spend with them should be spent using the practices that are most likely to be successful. This requires us to shift our perspective from looking at instructional practices that work to looking at what instructional practices work BEST.



Works Best?

Meta-analysis offer the strongest evidence base for determining what works best. "A Meta-analysis is a summary, or synthesis of relevant research findings. It looks at all of the individual studies done on a particular topic and summarizes them." (Marzano, 2000). A meta-analysis is simply, a study of studies. Meta-analysis explain the results across studies examined using effect size (ES). Average effects for instruction is 0.20 to 0.40 growth per year (Hattie, 2009). Thus the hinge point for determining what works best is 0.40. Instructional practices above the 0.40 have a high likelihood of increasing learning than those practices below the hinge-point (Hattie, 2009).

INSTRUCTIONAL PRIORITIES

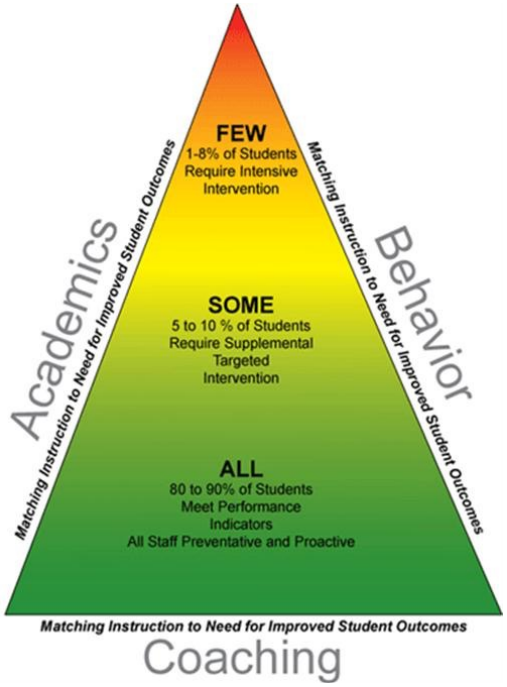
Techniques to increase Student Achievement and Engagement.

Overview

Priority	Critical Actions for Educators
Classroom Positive Behavioral Interventions and Supports (PBIS)	*Clearly identify behavior expectations and explicitly teach them to your students. *Implement reinforcement system for appropriate behavior and routinely evaluate the system for effectiveness. *Recognize students for positive behavior. *Systematically correct problem behaviors.
Explicit Instruction (I do, We do, Y'all do, You do)	*Give clear, straightforward, and unequivocal directions. *Explain, demonstrate and model. Introduce skills in a specific and logical order. Support this sequence of instruction in your lesson plans. *Break skills down into manageable steps. Review frequently. *Demonstrate the skills for students and give opportunity to practice skills independently.
Instructional Hierarchy: Acquisition, Automaticity, then Application (AAA)	*Explicitly teach a skill to students by explaining, demonstrating, and modeling. *Build the skill through practice and use, to gain automaticity. *Provide students with multiple opportunities to apply the skill.
Systematic Vocabulary Development	*Explicitly teach critical vocabulary before students are expected to use it in context. *Teach students to say, define, and use critical vocabulary in discreet steps. *Explicitly teach common academic vocabulary across all content areas.
Maximizing Opportunities to Respond (OTR)	*Actively engage ALL students in learning; students are active when they are saying, writing, or doing. *Pace instruction to allow for frequent student responses. *Call on a wide variety of students throughout each period.
Feedback Cycle	*Provide timely prompts that indicate when students have done something correctly or incorrectly. *Give students the opportunity to use the feedback to continue their learning process. *End feedback with the student performing the skill correctly and receiving positive acknowledgement.
Scaffolded Instruction and Grouping Structures	*Present information at various levels of difficulty. *Use data to identify needs and create small groups to target specific skills. *Frequently analyze current data and move students within groups depending on their changing needs.

CLASSROOM PBIS

Effect Size: 0.52



Critical Actions for Educators

*Clearly identify behavior expectations and explicitly teach them to students.

*Implement reinforcement system for appropriate behavior and routinely evaluate the system for effectiveness.

*Recognize students for positive behavior.

*Systematically correct problem behaviors.

The heart of classroom management is developing routines and environments that promote student success through the active teaching of positive social behaviors.

A well-implemented positive classroom management system will:

- Increase positive behavior in students.
- Help students feel more positive towards their teacher, administrator and school.
- Help students feel safer in school.
- Increase time for academic instruction and decrease teacher time spent correcting problem behaviors.

PBIS, or Positive Behavioral Interventions and Supports, is an evidence-based system that helps define the key components of a well-managed classroom. The key components include:

- Clearly establishing student rules
- Explicitly teaching rules
- Reinforcing positive behaviors and correcting negative behaviors
- Creating a supportive classroom

CLASSROOM PBIS

Effect Size: 0.52

Key Component	Definition

Clearly Establishing Student Rules	• Select 3-5 positively stated & easily remembered rules that align with the school wide rules in your building.
	  • The school's rules might be: Be Safe, Be Kind, Be Responsible. It is appropriate to adopt these same rules for your classroom, and add one or two additional rules that fit the needs of your setting if necessary. It is important to explicitly describe what these rules look like in your classroom.
	• Publicly post rules in the classroom in a prominent location.
	• Determine which routines are needed for your classroom (a routine is a set of skills explicitly taught to students to help them be successful with following the rules). Examples may include:
	  • Walking in the hallway
	  • Classroom exit
	  • Starting and ending class
	  • Sharpening pencils
	  • Going to the restroom
	  • Transitioning from one activity to the next
	  • Technology use in the classroom

Explicitly Teaching Rules	• Explicitly teach classroom rules and routines to students.
	  • Define and model positive examples and non-examples of what the rules look like in your classroom.
	  • Have students model and practice performing the desired behaviors.
	  • Provide positive feedback and corrective feedback as needed during practice of the desired behaviors.
	• Review and practice the rules with students throughout the school year.
	  • Rules should be reviewed more comprehensively at the beginning of each year, after significant breaks in the school schedule (e.g. Thanksgiving, Christmas, Spring), and as needed.
	• Example Routine
	  • Classroom exit: Describe and model the routine to your students, have students practice lining up, and going back to their seats. Make sure that 100% of students demonstrate the behavior correctly. This may require you to practice several times while providing positive and corrective feedback.

CLASSROOM PBIS

Effect Size: 0.52

Key Component	Definition

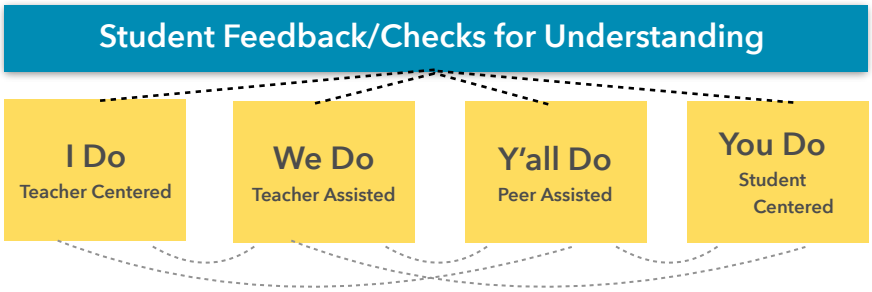
Reinforcing Positive Behaviors and Correcting Negative Behaviors	• It is important to publicly recognize positive behavior, while individually providing corrective feedback when needed. Students should be monitored closely while in the classroom and feedback should be given often. Public positive statements often prompt other students to exhibit the desired behavior.
	  • Example: "I really like the way Sarah is waiting for instructions. She has her materials ready, and she's sitting quietly at her desk."
	• When correcting negative behavior, provide a precision request to students (whole group) to describe desired behavior. Based on student response, provide positive feedback to the group. If undesired behaviors continue follow-up with a statement of the desired behavior directed to the target student in a private manner as needed. Give the student an opportunity to comply and perform the behavior correctly, and then reward the student with positive feedback.
	  • Example: "I need everyone to be in their seats, have materials ready, and wait quietly for instructions." Teacher observes Sarah talking during the transition, so he/she approaches Sarah quietly. "Sarah, the rule in our class is to wait quietly for instructions. I need you to show me how you sit quietly for instructions." While Sarah is performing the desired behavior, you might say, "Sarah, I appreciate how you are waiting quietly. Great job."

Creating a Supportive Classroom	Creating a safe and respectful learning environment allows students to feel supported while learning. It is necessary for teachers to find opportunities to establish positive connections with all students. A teacher's daily interactions influence the students' perception of safety and sense of trust. Considerations for creating a supportive classroom include: • Make personal connections with students • Help students feel like they belong • Establish clear classroom norms to demonstrate respect for others • Create consistent rules, routines, and arrangements (fosters predictability) • Weave positive feedback into daily interactions with students and parents • Be available for students (e.g. to ask questions, seek guidance) • Actively listen • Set a positive tone for learning and problem solving • Be aware of your personal emotions, assumptions, and biases and how they may impact your interactions with students

EXPLICIT INSTRUCTION

Effect Size: 0.57

Explicit instruction is a systematic method of teaching with emphasis on; proceeding in small steps, checking for student understanding, and achieving active and successful participation by all students.



The model is generally characterized with the following components: I Do, We Do, Y'all Do, and You Do. Teachers use student feedback to determine how to progress through the model. For instance, if students are in the "We Do" phase, and the teacher has determined that students aren't understanding, they should move back to the "I Do" phase to provide more examples.

Explicit Instruction	
I Do (Modeling)	Demonstrate & Describe Use Think-Alouds Involve Students
We Do (Guided Practice)	Heavily Scaffolded with Prompts • Tell them what to do. • Ask them what to do. • Remind them what to do. Continual Checks for Understanding
Y'all Do (Group Practice)	Practice Skill in Small Groups/Partners Continual Checks for Understanding Use Precision Partnering
You Do (Individual Practice)	Monitored Individual Practice Show Mastery of Skill

Critical Actions for Educators

*Give clear, straightforward, and unequivocal directions.
*Explain, demonstrate and model. Introduce skills in a specific and logical order. Support this sequence of instruction in your lesson plans.
*Break skills down into manageable steps. Review frequently.
*Demonstrate the skills for students and then give the opportunity to practice skills independently.
* I do, We Do, Y'all Do, You Do.

INSTRUCTIONAL HIERARCHY

Effect Size: 0.57

Critical Actions for Educators

*Explicitly teach a skill to students by explaining, demonstrating, and modeling.
*Build the skill through practice and use, to gain automaticity.
*Provide students with multiple opportunities to apply the skill.

Learners follow predictable stages. To begin, the learner is usually halting and uncertain as she tries to use a new skill. With feedback and a lot of practice, the learner becomes increasingly accurate, then automatic (fluent), and confident in using the skill.

Acquisition, automaticity, and application are progressive stages of the instructional hierarchy. Each stage requires its own set of pedagogical approaches and assessment strategies.

The learning stages, along with the goal of each phase and the teacher and student actions present in each stage are listed in the table below.

Accurate at Skill

- If no, teach skill.
- If yes, move to automaticity.

Automatic at Skill

- If no, teach automaticity.
- If yes, move to application.

Able to Apply Skill

- If no, teach application.
- If yes, move to higher level/concept or repeat cycle with new knowledge.

INSTRUCTIONAL HIERARCHY

Effect Size: 0.57

Learning Stage	Goal	Teacher and Student Actions
Acquisition • First learning stage • Teacher feedback to increase accuracy • Typically associated with DOK 1	The student can perform the skill accurately with little adult support. If goal met proceed to automaticity stage; if not teach skill.	• Teacher actively demonstrates target skill • Teacher uses 'think-aloud' strategy-- especially for thinking skills that are otherwise covert • Student has models of correct performance to consult as needed (e.g., correctly completed math problems on board) • Student gets feedback about correct performance • Student receives praise, encouragement for effort • Students take notes, outlines, points
Automaticity • Builds habits and fluent skills through repetition and deliberate practice with timely and descriptive feedback • Typically associated with DOK 2	The student has learned skill well enough to retain, to combine with other skills, and is as fluent as peers. If observed proceed to application; if not continue or move back to acquisition.	• Teacher structures learning activities to give student opportunity for active (observable) responding • Student has frequent opportunities to drill (direct repetition of target skill) and practice (blending target skill with other skills to solve problems) • Student gets feedback on fluency and accuracy of performance • Student receives praise, encouragement for increased fluency
Application • Applying knowledge or skills to relevant application • Typically associated with DOK 3 & 4	The student uses the skill across situations and settings solving real life problems. If observed, move to new skills and knowledge or move to a higher level concept; if no observed try again or go back to building automaticity	• Teacher structures academic tasks to require that the student use the target skill regularly in assignments. • Student receives encouragement, praise for using skill in new settings, situations • Teacher works with parents to identify tasks that the student can do outside of school to practice target skill • Teacher helps student to articulate the 'big ideas' or core element(s) of target skill that the student can modify to face novel tasks, situations • Encourage student to set own goals for adapting skill to new and challenging situations.

EXPLICIT VOCABULARY

Effect Size: 0.57

Explicit vocabulary instruction is clear, concise vocabulary instruction presenting the meaning and contextual examples of a word through multiple exposures. It is not the traditional procedure of having students copy a list of words, looking up words, copying definitions, or memorizing definitions.

Systematic vocabulary instruction increases reading comprehension, allows for greater access to content material, increases growth in vocabulary knowledge, and supports struggling readers.

Effective vocabulary/academic language instruction comes down to:

- Connection: Connect the new word to what the student knows, which helps to build the "semantic network" in the brain.
- Use: Academic speaking and writing is constructed as we apply it, not by simply memorizing.

Teacher should explicitly teach worlds that are:

- Based on essential concepts
- Unknown
- Critical to the future
- Difficult to obtain independently (or through context

Critical Actions for Educators

*Explicitly teach critical vocabulary before students are expected to use it in context.
*Teach students to say, define, and use critical vocabulary in discreet steps.
*Explicitly teach common academic vocabulary across all content areas.

Basic Instructional Protocol	
1. Introduce the Word 2. Provide Student Friendly Definition of the Word 3. Identify Word Parts, Families, and Origin 4. Illustrate word with Examples	5. Check students' understanding 6. Deepen students' understanding 7. Check students' understanding 8. Review & Coach Use (possible extensions)

OPPORTUNITIES TO RESPOND

Effect Size: 0.57

Critical Actions for Educators

*Actively engage ALL students in learning; students are active of they are saying, writing, or doing.
*Pace instruction to allow for frequent student responses.
*Call on a wide variety of students throughout each period.

Maximizing the opportunities to respond in a classroom increases students engagements. Engagement allows for positive interactions between teacher and student, creates opportunities for teachers to provide authentic feedback on learning, and decreases inappropriate student behavior.

Students are engaged through opportunities to respond when they are saying, writing, or doing (Feldman). When tied to learning objectives, these opportunities give the teacher and students feedback on their learning and understanding.

Engagement opportunities can be focused on an individual student or a group of students. Each of these approaches has different purposes. The teacher may choose to use a group OTR to minimize the risk the student feels in responding and to increase engagement for all students. Through group OTRs, students not only receive feedback from the teacher, but their peers as well as they hear and see other student responses. When seeking individual student understanding, teacher may choose to use individual OTRs.

Opportunities to respond can be verbal or non-verbal. Verbal responses help students to summarize and share their thoughts with others while non-verbal responses can increase writing skills or give students the opportunity to move around the room.

Structured Non-Verbal	Structured Verbal	Structured Writing	Structured Reading
• Cold Calling (Teacher Chosen) • Cold Calling (Random) • Choral Response • Think Pair Share • Precision Partner • Small Group Discussion	• Hand Signals • Point at Something • 4 Corners • Response Cards • White Boards • Student Response System	• Note-Taking: Cloze, Cornell • Graphic Organizer • Sentence Starter/ Quick Write • White Boards • Summarizing • Technology	• Partner Reading w/ Comprehension Strategy • Choral Reading • Cloze Reading Guide • Model Reading Strategies • Task for each Reading Segment

FEEDBACK

BETWEEN TEACHERS & STUDENTS

Effect Size: 0.75

Feedback lets the learner know whether or not a task was performed correctly, and how it might be improved. Feedback is most effective when it is clear, purposeful, compatible with prior knowledge, immediate, and non-threatening.

Feedback from Students:
Educational research indicates that feedback is one of the most powerful drivers of student achievement. John Hattie's synthesis of the overall effect size of feedback is very high (ES = .75). He states that feedback from students as to what they understand, when they are not engaged, where they make errors, and when they have misconceptions helps make student learning visible to the teacher.

Feedback to Students:
Positive academic and behavioral feedback, or teacher praise has been statistically correlated with student on-task behavior (Apter, Arnold & Stinson, 2010) and has strong empirical support for both increasing academic and behavioral performance and decreasing problem behaviors (Gable, Hester, Rock & Hughes, 2009). With regard to reprimands and corrective feedback, there is a continued assertion that teachers maintain a ratio of praise to correction at 3:1 or 4:1 (Gable, Hester, Rock, & Hughes, 2009; Stichter, Lewis, & Wittaker, 2009).

Critical Actions for Educators

*Provide timely prompts that indicate when students have done something correctly or incorrectly.
*Give students the opportunity to use the feedback to continue their learning process.
*End feedback with the student performing the skill correctly and receiving positive acknowledgement.

Feedback Types:

Type	Description	Example	Non-Example
Positive	Teacher indicates that a target academic or social behavior is correct.	"Correct! 7 X 4 is 28"	"Johnny, pick up your pencil off the floor please
Corrective	Teacher indicates that a behavior is incorrect.	"That's not quite right, let me give you another clue . . . "	"Try harder on your math worksheet; I know you can do better."
Harsh	Teacher shows frustration or is critical of the student.	I can't believe you **still** can't figure this out!	"Let me give you another clue . . . "
Neutral	Teacher redirects the student or describes what she would like the student to do.	"Johnny, turn to page 4 and start reading."	"Nice work! You really showed justification for your reasons."

FEEDBACK CYCLE

Effect Size: 0.75

	Example	Non-Example
Corrective Sequence	• Teacher provides an opportunity to respond • Student responds incorrectly • Teacher indicates that the response was not correct and provides an opportunity for correction • Student gives correct response • Teacher affirms that response was correct	• Teacher provides an opportunity to respond • Student responds incorrectly • Teacher indicates that the response was not correct but does not provide an opportunity for the student to answer correctly
Expansive Sequence	• Teacher provides an opportunity to respond • Student response is a partial response or could be expanded into a higher quality response • Teacher affirms response and provides guidance for expansion/refinement • Student revises or elaborates upon previous response • Teacher acknowledges response as an improvement.	• Teacher provides an opportunity to respond • Student response is a partial response or could be expanded into a higher quality response • Teacher affirms response but does not provide guidance for expansion/refinement
Challenge Sequence	• Teacher provides and opportunity to respond • Student response is fully correct • Teacher affirms student response and asks a more difficult question on the same topic as a follow up • Student answers • Teacher responds with positive or corrective feedback	• Teacher provides and opportunity to respond • Student response is fully correct • Teacher affirms student response but does not ask a more difficult question on the same topic as a follow up

SCAFFOLDING & GROUPING

Effect Size: 0.57

Scaffolding is a process in which students are given support until they can apply new skills and strategies independently (Rosenshine & Meister, 1992). When students are learning new or challenging task, they are given more assistance. As they begin to demonstrate task mastery, the assistance or support is decreased gradually in order to shift the responsibility for learning from the teacher to the students. Thus, as the students assume more responsibility for learning, the teacher provides less support.

Structure of the Scaffolded Classroom:
The organization of the scaffolded classroom includes whole group, small group (skill-based or station teaching), partners, and independent work. The scaffolding supports that will be put in place for diverse learners should include interventions for striving and accelerated learners. When using small groups, identify the groups as skill-based or station teaching. Skill-based groups are organized homogeneously based upon the needs of students. Station teaching groups are organized heterogeneously to create diverse groups.

Critical Actions for Educators

*Present information at various levels of difficulty.
*Use data to identify needs and create small groups to target specific skills.
*Frequently analyze current data and move students within groups depending on their changing needs.

Types of Scaffolds

Scaffold	Ways to use Scaffolds in an Instructional Setting
Advance Organizers	Tools used to introduce new content and tasks to help student learn about the topic: Venn diagrams to compare and contrast information; flow charts to illustrate processes; organizational charts to illustrate hierarchies; outlines that represent content; mnemonics to assist recall; statements to situate the task or content; rubrics that provide task expectations.
Checklists	Prepare a list of items required, things to be done, or points to be considered, used as a reminder as the student proceeds through the learning task.
Collaborative Grouping	Having students work in partners or small groups with students who can support/model students who may struggle with content.
Concept and Mind Maps	Maps that show relationships: Partially or completed maps for students to complete; students create their own maps based on their current knowledge of the task or concept.
Cue Cards	Prepared cards given to individual groups of students to assist in their discussion about a particular topic or content area: Vocabulary words to prepare for exams; content-specific stem sentences to complete; formula to associate with a problem; concepts to define.
Examples	Samples, specimens, illustrations, problems, modeling: Real objects; illustrative problems used to represent something. Demonstrate and model how to do something, giving an example of what it should look like.
Explanations	More detailed information to move students along on a task or in their thinking of a concept: Written instructions for a task; verbal explanation of how a process works.

Scaffold	Ways to use Scaffolds in an Instructional Setting
Handouts	Prepared handouts that contain task and content-related information, but with less detail and room for student note taking.
Images and Multimedia	Providing an image or other graphic representation, such as a video, that represents the word(s)/concept(s) being taught in conjunction with the explicit vocabulary routine can help to support students in learning new vocabulary and concepts. Images help provide a non-linguistic representation and allow students to recall the term more readily. This technique can be used with any Reading Street Vocabulary (Amazing Words, Story/Lesson Vocabulary), Math Vocabulary, or Content Vocabulary or concepts.
Manipulatives	Manipulatives, such as markers, toothpicks, blocks, or coins, are used to support hands-on learning and provide concrete models to help students solve problems and develop concepts. The students can manipulate the items to increase their understanding and come to accurate conclusions. May also include virtual manipulatives.
Pair-Share	Pose a problem, students have time to think about it individually, and then they work in pairs to solve the problem and share their ideas with the class. Providing think time increase the quality of the response.
Precision Partnering	Strategically appointed partners with assigned roles.
Previewing Text	Before reading a text, preview the text by providing students with an overview/synopsis of the text. This will allow students to know what to expect when they are reading and give them background knowledge to help them understand the text.
Prompts	A physical or verbal cue to remind–to aid in recall of prior or assumed knowledge. Physical: Body movements such as pointing, nodding the head, eye blinking, foot tapping. Verbal: Words, statements and questions such as "Go," "Stop," "It's right there," "Tell me now," "What toolbar menu item would you press to insert an image?" "Tell me why the character acted that way."
Question Cards	*Prepared cards with content and task-specific questions* given to individuals or groups of students to ask each other pertinent questions about a particular topic or content area.
Question Stems	*Incomplete sentences which students complete:* Encourages deep thinking by using higher order "What if" questions.
Realia	Anytime the real object, concept, or phenomena can be presented with the actual object helps to support learners in acquiring new ideas and concepts. For example, when teaching about the three types of rocks, having examples of those types for students to see and touch can help them to make deeper connections.
Rubrics	A rubric is an easily applicable form of authentic assessment. A rubric simply lists a set of criteria, which defines and describes the important components of the work being planned or evaluated.
Sentence Frames	*Sentence frames provide an opportunity for students to use key vocabulary while providing a structure* that may be higher than what they could produce on their own. For example, if students are to compare two ocean creatures, they might say something like "Whales have lungs, but fish have gills." In the preceding sentence, the simple frame is "_____ have _____, but _____ have _____. Note the sentence can be filled in with any content; this differs from closed sentences that often have only a few possibilities.
Setting & Reviewing Objectives	*Providing students with a purpose and intended outcome* will help students to know what to focus their attention on and what they should be learning. Having student self-assess their progress towards the objectives at the end of the lesson will provide the teacher with information on their current levels of understanding.
Socratic Seminar	The purpose of a Socratic Seminar is to achieve a deeper understanding about the ideas and values in a text. In the Seminar, participants systematically question and examine issues and principles related to a particular content, and articulate different points-of-view. The group conversation assists participants in constructing meaning through disciplined analysis, interpretation, listening, and participation. Prepare several questions in advance in addition to questions that students may bring to class. Questions should lead participants into the core ideas and values and to the use of the text in their answers. Questions must be open-ended, reflect genuine curiosity, and have no "one-right answer."
Stories	*Stories relate complex and abstract material to situations more familiar with students:* Recite stories to inspire and motivate learners.
Student Work Exemplars	*Providing students with example student work samples can provide models for students to use to support their development of the skill.* For example, an anchor paper for a writing assignment of how a sample student responded to the assignment previously will provide an example of what the assignment looks like.
Visual Scaffolds	Pointing to call attention to an object; representational gestures (holding cured hands apart to illustrate roundness; moving rigid hands diagonally upward to illustrate steps or process), diagrams such as charts and graphs; methods of highlighting visual information.

Webb's Depth of Knowledge (DOK)

Webb's Depth of Knowledge (DOK) provides a vocabulary and a frame of reference that connects the type of thinking with the complexity of the task. Using DOK levels offers a common language to understand "rigor," or cognitive demand, in assessments, as well as curricular units, lessons, and tasks. Consequently, teachers need to develop the ability to design questions, tasks and classroom assessments for a greater range of cognitive demand. Most often a scaffolded support is needed to help students organize or break down information. All learners K-12 should experience a variety of DOK levels.

Depth of Knowledge Generalizations:

If there is one correct answer, it is most likely a DOK 1 or DOK 2.

- DOK 1: Either you know it or you don't
- DOK 2: Make connections with known information

If there is more than one answer, requiring supporting evidence, it is a DOK 3 or DOK 4.

- DOK 3: Interpret implied information, provide supporting evidence and reasoning. Explain not just HOW but WHY for each step and decision made
- DOK 4: Includes all of DOK 3 and the use of multiple sources/data/ texts

DOK Level 1: Recall & Reproduction	
Students are to recall or reproduce knowledge and /or skills. Content involves working with facts, terms, details and calculations. Level 1 items have a correct answer with nothing to reason or figure out.	
Teacher Role	**Student Role**
Questions to direct or focus attention, shows, tells, demonstrates, provides examples, examines, leads, breaks down, defines	Recognizes, responds, remembers, memorizes, restates, absorbs, describes, demonstrates, follows directions, applies routine processes, definitions, and procedures
Possible Task and Products	
• Fill in the blank • Quiz • Calculate, compute • Oral reading fluency • Decoding words • Write complete sentences • Document with highlighting/ citing/ annotating sources • Locate and recall quotes • Recite math facts, poems etc.	• Write a list of key words about . . . • Memorize lines • Complete basic calculation tasks (e.g., add, subtract, divide, multiply) • Complete measurement tasks using rulers or thermometers • Read for fact/details or plot • Locate or retrieve information in verbatim form to answer a question
Potential Questions	
Can you recall _____? When did _____ happen? Who was_____? How can you recognize_____? What is ___? How can you find the meaning of _____?	Can you select_____? How would you write _____? What might you include on a list about _____? Who discovered ____? What is the formula for ____? Can you identify ____?

Hess, 2013. Adapted from A Guide for Using Webb's Depth of Knowledge with Common Core State Standards

Webb's Depth of Knowledge (DOK)

DOK Level 2: Skill/Concept	
Includes the engagement of mental processing beyond recalling, reproducing or locating an answer. This level generally requires students to compare and contrast, cause and effect, classify, or sort items into meaningful categories, describe or explain relationships, provide examples and non-examples.	
Teacher Role	**Student Role**
Provides questions to differentiate, infer, or check conceptual understanding, models, organizes,/reorganizes, explores, possible options or connections, provides, examples and non-examples	Solves routine problems/tasks involving multiple decisions points and concepts, constructs models to show relationships, demonstrates use of conceptual knowledge, compiles and organizes, illustrates with examples or models and examines.
Possible Tasks and Products	
• Timeline • Number line • Graphic organizer • Science logs • Concept Maps • Captioned Story Board	• Write a summary • Explain a series of steps used to find a solution • Sequence of events using a graphic organizer • Explain the meaning of a concept using words, objects and/or visuals • Complex calculations involving decision points • Conduct, collect, and organize data
Potential Questions:	
What other way could you solve/find out___? What is your prediction and why? How would you organize ___ to show _____? Can you explain how ___ affected ____? How would you apply what you learned to develop ___? How would you compare ___ and contrast ___? How would you classify?	What facts are relevant to show_____? How or why would we use_____? What examples or non-examples can we find? What is the relationship between ___ and ___? How would you summarize? How are __ alike and different? What do you notice about ___? How would you estimate_____?

Hess, 2013. Adapted from A Guide for Using Webb's Depth of Knowledge with Common Core State Standards

Webb's Depth of Knowledge (DOK)

DOK Level 3: Strategic Thinking and Reasoning

Stating reasons and providing relevant supporting evidence are key markers of DOK 3 tasks. The expectation established for tasks at his level require an in-depth integration of conceptual knowledge and multiple skills to reach a solution or produce a final product. DOK 3 tasks focus on in-depth understanding of **one** text, **one** data set, **one** investigation, or **one** key source.

Teacher Roles	Student Role
Questions to probe reasoning and underlying thinking, asks open-ended questions, acts as a resource and coach, provides criteria and examples for making judgments and supporting claims. Encourages multiple approaches and solutions and determines when in depth exploration is appropriate.	Uncovers and selects relevant and credible supporting evidence for analyses, critiques, debates, claims and judgments, plans, initiates questions, disputes, argues, tests ideas/solutions, sustains inquiry into topics or deeper problems, applies to the real world.

Possible Tasks and Products:

- Complex graph
- Analyze survey results
- Multiple paragraph essay or short story
- Fact-based argument
- Chart and draw conclusions about data sets
- Investigation
- Drawing conclusions from text or data sets
- Generalize from a set of evidence or data
- Justification of the solution to a problem
- Debate from a given perspective
- Use a Venn Diagram that shows how two topics from the same source are the same and different
- Design a questionnaire to gather information
- Survey classmates/industry members to find out what they think about a particular topics
- Make a flow chart to show the critical stages.
- Participate in a discussion that represents different viewpoints
- Write a opinion essay
- Convince others with evidence
- Solve non-routine problems
- Interpret information from a complex graph

Potential Questions

How is ___ related to _____?
What are the possible flaws in ____ ?
What is the theme/lesson-learned ____?
How would the moral change if ____?
What underlying bias is there ____?
What inferences will these facts support____?
How does the author create tension/suspense____?
What is the author's reasoning for____?
How can you prove that your solution is reasonable?
What evidence can you find to support_____ ?
What ideas justify _____?
What conclusions can you draw?
What information can you draw on to support your reason for _____?
How would you ____ to create a different _____?
What is the best answer and why?
Can you elaborate on your reason and give examples?

Hess, 2013. Adapted from A Guide for Using Webb's Depth of Knowledge with Common Core State Standards

Webb's Depth of Knowledge (DOK)

DOK Level 4: Extended Thinking

Stating reasons and providing relevant supporting evidence are key markers of DOK 4 tasks. The expectation established for tasks at his level require an in-depth integration of conceptual knowledge and multiple skills to reach a solution or produce a final product. DOK 4 tasks focus on in-depth understanding of **multiple** texts, **multiple** data sets, **multiple** investigations, or **multiple** key sources.

Teacher Roles	Student Role
Questions extend thinking and broaden perspectives; facilitates teaming, collaboration and self-evaluation of students.	Designs, takes risks, researches synthesizing multiple sources, collaborates, plans, organizes, modifies, creates concrete tangible products.

Possible Tasks and Products:

- Presentation—using diverse media formats
- Research report synthesizing multiple sources
- Essay (informational, narrative or opinion) using multiple sources
- Multiple data sources synthesized to develop original graphs
- Assessment based on application of the content knowledge
- Applying information from more than one discipline to solve non-routine problems in novel or real-world situations.
- Tasks that require making multiple strategic and procedural decisions as new information is processed
- Tasks that require multiple roles and collaboration with others. (peer revision, editing of a script)
- Tasks that draw evidence from multiple sources to support solutions/conclusions

Potential Questions—all require multiple sources for evidence

What evidence would you cite to defend the actions of____?
How would you evaluate this author over time?
Can you predict the potential benefits and drawbacks of this given situation?
What information would you use to support a differing perspective?
What changes would you make to solve or address this major issue/problem _____?
Can you propose an alternate solution?
Do you agree with the actions, outcomes, or decisions?
How would you prove or disprove?
Can you assess the value or importance of?

Hess, 2013. Adapted from A Guide for Using Webb's Depth of Knowledge with Common Core State Standards

Table 1: Detailed Descriptors of Depth-of-Knowledge Levels for Science
(K. Hess, Center for Assessment, based on Webb, update 2005)

Level 1 **Recall & Reproduction**	**Level 2** **Skills & Concepts**	**Level 3** **Strategic Thinking**	**Level 4** **Extended Thinking**
a. Recall or recognize a fact, term, definition, simple procedure (such as one step), or property b. Demonstrate a rote response c. Use a well-known formula d. Represent in words or diagrams a scientific concept or relationship e. Provide or recognize a standard scientific representation for simple phenomenon f. Perform a routine procedure, such as measuring length g. Perform a **simple** science process or a set procedure (like a recipe) h. Perform a clearly defined set of steps i. Identify, calculate, or measure	a. Specify and explain the relationship between facts, terms, properties, or variables b. Describe and explain examples and non-examples of science concepts c. Select a procedure according to specified criteria and perform it d. Formulate a routine problem given data and conditions e. Organize, represent, and compare data f. Make a decision as to how to approach the problem g. Classify, organize, or estimate h. Compare data i. Make observations j. Interpret information from a simple graph k. Collect and display data	a. Interpret information from a complex graph (such as determining features of the graph or aggregating data in the graph) b. Use reasoning, planning, and evidence c. Explain thinking (beyond a simple explanation or using only a word or two to respond) d. Justify a response e. Identify research questions and design investigations for a scientific problem f. Use concepts to solve non-routine problems/more than one possible answer g. Develop a scientific model for a complex situation h. Form conclusions from experimental or observational data i. Complete a multi-step problem that involves planning and reasoning j. Provide an explanation of a principle k. Justify a response when more than one answer is possible l. Cite evidence and develop a logical argument for concepts m. Conduct a designed investigation n. Research and explain a scientific concept o. Explain phenomena in terms of concepts	a. Select or devise approach among many alternatives to solve problem b. Based on provided data from a complex experiment that is novel to the student, deduct the fundamental relationship between several controlled variables. c. Conduct an investigation, from specifying a problem to designing and carrying out an experiment, to analyzing its data and forming conclusions d. Relate ideas *within* the content area or *among* content areas e. Develop generalizations of the results obtained and the strategies used and apply them to new problem situations

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	○ Recall, observe, & recognize facts, principles, properties ○ 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	○ Evaluate an expression ○ Locate points on a grid or number on number line ○ Solve a one-step problem ○ Represent math relationships in words, pictures, or symbols ○ Read, write, compare decimals in scientific notation	○ Specify and explain relationships (e.g., non-examples/examples; cause-effect) ○ Make and record observations ○ Explain steps followed ○ Summarize results or concepts ○ Make basic inferences or logical predictions from data/observations ○ Use models /diagrams to represent or explain mathematical concepts ○ Make and explain estimates	○ Use concepts to solve non-routine problems ○ Explain, generalize, or connect ideas using supporting evidence ○ Make and justify conjectures ○ Explain thinking when more than one response is possible ○ Explain phenomena in terms of concepts	○ Relate mathematical or scientific concepts to other content areas, other domains, or other concepts ○ 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	○ Follow simple procedures (recipe-type directions) ○ Calculate, measure, apply a rule (e.g., rounding) ○ Apply algorithm or formula (e.g., area, perimeter) ○ Solve linear equations ○ Make conversions among representations or numbers, or within and between customary and metric measures	○ Select a procedure according to criteria and perform it ○ Solve routine problem applying multiple concepts or decision points ○ Retrieve information from a table, graph, or figure and use it solve a problem requiring multiple steps ○ Translate between tables, graphs, words, and symbolic notations (e.g., graph data from a table) ○ Construct models given criteria	○ Design investigation for a specific purpose or research question ○ Conduct a designed investigation ○ Use concepts to solve non-routine problems ○ Use & show reasoning, planning, and evidence ○ Translate between problem & symbolic notation when not a direct translation	○ Select or devise approach among many alternatives to solve a problem ○ 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	○ Retrieve information from a table or graph to answer a question ○ Identify whether specific information is contained in graphic representations (e.g., table, graph, T-chart, diagram) ○ Identify a pattern/trend	○ Categorize, classify materials, data, figures based on characteristics ○ Organize or order data ○ Compare/ contrast figures or data ○ Select appropriate graph and organize & display data ○ Interpret data from a simple graph ○ Extend a pattern	○ Compare information within or across data sets or texts ○ Analyze and draw conclusions from data, citing evidence ○ Generalize a pattern ○ Interpret data from complex graph ○ Analyze similarities/differences between procedures or solutions	○ Analyze multiple sources of evidence ○ analyze complex/abstract themes ○ Gather, analyze, and evaluate information
Evaluate Make judgments based on criteria, check, detect inconsistencies or fallacies, judge, critique			○ Cite evidence and develop a logical argument for concepts or solutions ○ Describe, compare, and contrast solution methods ○ Verify reasonableness of results	○ Gather, analyze, & evaluate information to draw conclusions ○ 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	○ Brainstorm ideas, concepts, or perspectives related to a topic	○ Generate conjectures or hypotheses based on observations or prior knowledge and experience	○ Synthesize information within one data set, source, or text ○ Formulate an original problem given a situation ○ Develop a scientific/mathematical model for a complex situation	○ Synthesize information across multiple sources or texts ○ Design a mathematical model to inform and solve a practical or abstract situation

Utah SAGE Science Blueprints

Chemistry 54 Scored Items		
Standard	**Min**	**Max**
Standard CH.1	15%	19%
Standard CH.2	15%	19%
Standard CH.3	15%	19%
Standard CH.4	15%	19%
Standard CH.5	15%	19%
Standards CH.6	15%	19%
ILO 1	22%	26%
ILO 3	24%	28%
ILO 4	22%	26%
ILO 5/6	24%	28%
DOK 1	9%	33%
DOK 2	22%	60%
DOK 3/4	20%	40%

NOTE: The percentage shown represents target aggregate values; individual student experiences will vary based on the adaptive algorithm.

DISCLOSURE: Depth of Knowledge (DOK) is an essential component of the Science instruction. As such, DOK is integrated in all science items throughout the Student Assessment of Growth and Excellence (SAGE) and their respective blueprints. All students will see a variety of DOK and item difficulty on the summative SAGE. For more information about DOK please see: http://static.pdesas.org/content/documents/M1-Slide_22_DOK_Hess_Cognitive_Rigor.pdf

Acronym and Key Term Glossary for Secondary Teachers

- **ACT:** The ACT was designed to measure academic skills required for success in college and university settings. College and universities commonly use results to help determine which students to admit. There are four college readiness benchmark areas: 1) English, 2) Mathematics, 3) Reading, and 4) Science. Student's reaching ACT benchmarks have a 75% or better chance of getting a "C" or higher and a 50% chance or better of getting a "B" or higher in a college course in that subject. The ACT is administered to all 11th graders within the Canyons School District in the spring.

- **BLT:** Building leadership teams are comprised of key members of the school staff and an external coach. Each school's BLT is charged with the following tasks:
    - To identify, plan, and develop the instruction, intervention, and supports for all students to be successful
    - To sustain improvement over time
    - To develop collective capacity for quality instruction (e.g. support all teachers in professional learning and growth)

- **Canvas:** Canvas is a LMS, Learning Management System, (i.e. a software application for the administration, documentation, tracking, reporting and delivery of online learning). Canvas was selected as the LMS for Canyons schools because of its extensive use in Utah institutes of higher learning, along with its ability to increase collaboration among students, teachers, and parents.

- **CBM:** Curriculum-Based Measurement – a brief standardized measurement procedure designed to ascertain a student's overall academic performance in a basic subject area: e.g. reading, spelling, or writing. CBMs were designed to help teachers monitor academic growth over time, so that instruction could be modified and learning rates accelerated.

- **CFA:** Common Formative Assessment – An assessment typically created collaboratively by a team of teachers responsible for the same grade level or course, in order to improve instruction with a current group of students. Common formative assessments are frequently administered throughout the year to identify:
    - Individual students who need additional time and support for learning
    - The teaching strategies most effective in helping students acquire the intended knowledge and skills
    - Program concerns – areas in which students generally are having difficulty achieving the intended standard, and
    - Improvement goals for individual teachers and the team
    - *Dufour (2004). *Learning by Doing*, p. 214

- **CSA:** Common Summative Assessment – An assessment typically created collaboratively by a team of teachers responsible for the same grade level or course in order to evaluate whether or not students reached common standards at the completion of an instruction cycle.

- **CTESS:** Canyons Teacher Effectiveness Support System- In compliance with Senate Bill 64, this is Canyons School District teacher evaluation system that includes documentation of student growth, evidence of instructional quality, and response to stakeholder input.

- **District-Wide Standards-Based Assessment**: These assessments are given in all content areas at key times during the school year. Data from these benchmarks will be used for student growth in compliance with House Bill 201.

- **DLT:** The District Leadership Team supports implementation of the CSD Academic Framework and is comprised of representatives from school and district administration. The DLT is charged with the following:
    - Develop tools necessary for successful scaling-up of CSD Framework (i.e. evidence-based practices)
    - Provide a consistent feedback loop between school leaders and district leaders
    - Provide cascading levels of support to building leaders
    - Implement the district academic plan

- **HMH Math Inventory:** Houghton Mifflin Harcourt math inventory is a research-based, adaptive assessment that measures math abilities and longitudinal progress from Kindergarten through Algebra II

- **IPLC:** Instructional Professional Learning Communities meet regularly to focus on data and instruction to improve student achievement.

- **IPOP**: Instructional Priorities Observation Protocol – The classroom observation tool used for evidence of instructional quality.

- **ISD:** The Instructional Supports Department (commonly known as the curriculum department). This is where you will find the content leads and support for the curriculum.

- **LMS: Learning Management System -** A software application for the administration, documentation, tracking, reporting and delivery of online learning. **Canvas** was selected as the LMS for Canyons schools because of its extensive use in Utah institutes of higher learning, along with its ability to increase collaboration among students, teachers, and parents.

- **MTSS:** Multi-tiered Systems of Support (see RtI) is practice of providing high quality instruction, using data to make decisions about instruction and intervention for students that is based upon the students' performance, and providing multiple levels of support for both academic and behavioral standards.

- **PBIS:** Positive Behavioral Intervention and Supports is an evidence-based system that helps define the key components of a well-managed classroom.

- **Progress Monitoring:** A procedure that involves frequent measurement of student performance for the purpose of evaluating a student's growth toward a targeted objective. For example, the trajectory of reading growth can be measured with weekly administration of R-CBM.

- **Lexile Scores:** Lexiles can be a measure of text difficulty or of reading proficiency. They range from 0 to 1700. Below is a list of descriptors of Lexile scores by grade level. Students reading in the Proficient and Advanced levels are on track to graduate college and career ready.

- **SEM:** Standard error of measurement is one standard deviation of error around a student's true score.

- **SRI:** Scholastic Reading Inventory is a computer administered reading test that measures inferential and literal reading comprehension skills. Scores are reported in a numeric Lexile scores. Percentile ranks are also available. SRI was designed primarily to match students with books of an appropriate level of difficulty. It measures both literal and inferential comprehension. It is a particularly good assessment for identifying advanced readers. It has a disadvantage of not being as sensitive to growth as are CBM measures, of being subject to student sloughing, and having limited reliability if administered a few number of times.

- **R-CBM:** Reading Curriculum-Based Measurement (R-CBM) also known as Oral Reading Fluency (ORF) and CBM-Read Aloud, this is a one-minute measure which results in two primary numerical scores: number of words read correctly per minute (or correct words per minute, CWPM), and percentage of correctly read words (accuracy rate). This measure is highly correlated with reading comprehension in elementary school but outlives its usefulness once students read at the same rate at which they speak. Maze has been identified as a more appropriate CBM once students are reading grade-level texts at rates above 130 words read correctly per minute, with greater than 97% accuracy.

- **Reliability:** The degree to which a measure is free of error. All tests contain error and it results from characteristics of the test (such as poorly designed questions), characteristics of the test taker (bad day, lack of sleep, misreading questions, anxiety, and lack of effort), and characteristics of the environment (distracting noises, room temperature, and distracting odors).

- **RtI:** "Response to Intervention" (see MTSS) is the practice of (1) providing high-quality instruction/intervention matched to student needs and (2) using learning rate over time and level of performance to (3) make important educational decisions". (Batsche et al, 2007).
- **Turnitin Revision Assistant:** A core-aligned formative writing tool that gives students immediate feedback on their writing.
- **Universal Screening:** A procedure in which all students are evaluated for the purpose of identifying those students who need more intensive interventions. For example, reading is a critical and foundational academic skill, for which CSD screens in middle school with the SRI.
- **Utah Core Standards:** The standards for teaching and learning adopted by the Utah State Board of Education and implemented by local school districts and charter schools with guidance and support from the Utah State Office of Education.

- **Validity:** The degree to which a test measures what it is intended to measure. Establishing the validity of a measurement procedure involves empirical study of item content, accurate prediction, and alignment with theories about what is being measured.

Chemistry Scope & Sequence
2016-2017

Suggested Pacing	About 7 Weeks		5 Weeks	5 Weeks	10 Weeks	4 Weeks	3 Weeks
Unit Title	**Introduction**	**1. Properties and structure of Matter, Atomic History and Nuclear Physics**	**2. Quantized Energy and Periodic Trends**	**3. Bonding, Intermolecular Forces, and Kinetic Molecular Theory**	**4. Chemical Reactions, Moles, and Stoichiometry**	**5. Solutions and Acids/Bases**	**6. Energy, Reaction Rates, Equilibrium, and Electrochemistry**
Standards	**Nature of Science**	I & II	I, II, & III	III	IV	VI	IV & V
Benchmark							
Essential Question	• What are classroom routines & procedures? • How do we solve problems using the scientific method? • How is data used to find patterns in nature?	• What is matter, and what is its origin in our universe? • How has our understanding of the atom changed over time? • What are the effects of changes in the nucleus of an atom?	• How is the frequency of emitted light related to changes in electron energy? • How does the arrangement of electrons in an atom determine the properties of that element?	• How do the structures, arrangements, and forces between atoms, ions, and molecules determine the chemical and physical properties of matter?	• How are atoms rearranged and/or electrons transferred during a chemical reaction? • How are chemical reactions represented? • Why is the mole an important measurement in chemistry?	• How do we interpret a chemical equation? • Why do some substances dissolve, while other substances settle out of a solution? • How are acids and bases related to hydrogen-ion concentration?	• How does energy drive chemical reactions? • What factors affect reaction rates? • What is chemical equilibrium? • How does an electrochemical cell work?
Literacy Standards: Reading	RST - 3	RST-2 RST-6	RST-4 RST-5	RST-3 RST-9	RST-7 RST-8	RST-6	RST-7 RST-10
Literacy Standards: Writing	WHST - 4	WHST-7 WHST-1b WHST-1e	WHST-2d WHST-2e WHST-2f	WHST-2f WHST-4 WHST-9	WHST-1	WHST-5 WHST-6	WHST-2

Chemistry Scope & Sequence
2016-2017

Chemistry Unit 1: Properties of Matter, Atomic History, and Nuclear Physics

Essential Questions	Supporting Questions	Key Terms
Properties of Matter • What is matter, and what is its origin in our universe?	• What are the particles that make up an atom? • What properties are used to describe matter? • How can matter change its form? • How do atoms of different elements differ from each other? • How do atoms of the same element differ from each other?	atom, element, nucleus, isotope, physical property, chemical property, physical change, chemical change, atomic number, atomic mass,
Atomic History • How has our understanding of the atom changed over time?	• What were the contributions of various scientists to our current understanding of the atom?	model, experiment, theory, proton, neutron, electron
Nuclear Physics • What are the effects of changes in the nucleus of an atom?	• What happens when an unstable nucleus decays? • How is the structure of atoms changed during fission and fusion? • What are the types of radiation associated with nuclear decay?	half-life, fission, fusion, radioactivity, radiation, nuclear radiation, decay, alpha radiation, beta radiation, gamma radiation

Science Core Standards		Student Learning Targets
Standards	**STANDARD I: Students will understand that all matter in the universe has a common origin and is made of atoms, which have structure and can be systematically arranged on the periodic table.** **Objective 2:** Relate the structure, behavior, and scale of an atom to the particles that compose it. a. Summarize the major experimental evidence that led to the development of various atomic models, both historical and current. b. Evaluate the limitations of using models to describe atoms.	• I can describe *why* and *how* elements are different types of atoms. • I can distinguish between a chemical change and a physical change. • I can compare and contrast the three subatomic particles: protons, neutrons, and electrons. • I can arrange the atomic models in order of their chronological development.

	c. Discriminate between the relative size, charge, and position of protons, neutrons, and electrons in the atom. d. Generalize the relationship of proton number to the element's identity. e. Relate the mass and number of atoms to the gram-sized quantities of matter in a mole. **Objective 1:** Recognize the origin and distribution of elements in the universe. a. Identify evidence supporting the assumption that matter in the universe has a common origin. b. Recognize that all matter in the universe and on earth is composed of the same elements. c. Identify the distribution of elements in the universe. d. Compare the occurrence of heavier elements on earth and the universe. **STANDARD II: Students will understand the relationship between energy changes in the atom specific to the movement of electrons between energy levels in an atom resulting in the emission or absorption of quantum energy. They will also understand that the emission of high-energy particles results from nuclear changes and that matter can be converted to energy during nuclear reactions.** **Objective 2:** Evaluate how changes in the nucleus of an atom result in emission of radioactivity. a. Recognize that radioactive particles and wavelike radiations are products of the decay of an unstable nucleus. b. Interpret graphical data relating half-life and age of a radioactive substance. c. Compare the mass, energy, and penetrating power of alpha, beta, and gamma radiation. d. Compare the strong nuclear force to the amount of energy released in a nuclear reaction and contrast it to the amount of energy released in a chemical reaction. e. e. After researching, evaluate and report the effects of nuclear radiation on humans or other organisms.	• I can compare and contrast the atomic models. • I can cite evidence that explains how the origin or formation of elements throughout the universe begins with the fusion of atoms • I can explain how fusion in stars forms elements up to and including iron. • I can explain how fusion in supernovae results in formation of heavy elements. • I can compare and contrast fission and fusion. • I can identify the three general methods of radioactive decay (alpha, beta, gamma). • I can apply the concept of half-life to solve problems. • I can describe how the strong nuclear force holds nuclei together. • I can compare and contrast isotopes of the same element. • I can write isotopes in both hyphen notation (hydrogen-1) and nuclear symbols H). • I can compare the energy of nuclear vs. chemical reactions • I can write balanced nuclear equations. • I can identify and critique arguments about nuclear energy based on scientific evidence.

Chemistry Scope & Sequence
2016-2017

Math Skills and/or Scientific Processing Skills		Implementation Ideas
Math	Interpreting data from a graph	• Have students analyze a decay curve for a radioactive element (Pearson Chemistry, 2012, p. 843).
Literacy Standards		**Literacy Implementation Ideas**
Reading	**RST-2:** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text **RST-6:** Analyze the author's purpose in providing an explanation, describing a procedure, or an experiment in a text, defining the question the author seeks to address	• Have students create a timeline of the various models of the atom, and summarize the key events leading to our current understanding of the atom. • Have students describe the question that an experiment was designed to test. For example have students read about one of the experiments that led to our current model of the atom and explain what question the experiment was designed to test.
Writing	**WHST-7:** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. **WHST-1b:** Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claims and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concern. **WHST-1e:** Provide a concluding statement or section that follows from or supports the argument presented.	• Have students research a question of their choice involving the effects of radiation on humans. Another question that could be researched is: how are various isotopes used for human benefit. • Have students research and write an argumentative essay on showing both sides to the use of nuclear power. • After students present both sides of the argument researched above, have students choose which side of the argument they agree with most and write a concluding statement supported by the arguments presented/researched.

Chemistry Scope & Sequence
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Resources (labs, demonstrations, English Language Learner resources, Nature Of Science/History Of Science, or other essentials):
Properties of Matter Demos: Tennis ball isotopes, sugar monster, distillation apparatus Labs: Thermometer calibration, Physical and chemical properties/change; Separation of sand, salt, and iron; isotopes of "pennium" lab **Atomic History** Demos: cathode ray tubes Video: Senior Physics- online (youtube) parts one and two **Nuclear Physics:** Labs: Half-life of Twizzlers lab, radioactive samples and penetrating power Videos: Island of Instability
Technology/Engineering Connections
Nuclear Physics: • Lab: radioactive samples and penetrating power then relate to radiation exposure to employees in nuclear power plants. • Discuss different disasters that have occurred in nuclear power plants and how we can make improvements for the future. • Discuss with students the storage of Nuclear Waste, and relate how that is happening in Utah. Could even have a class debate on the topic. • Have students debate benefits of nuclear energy vs. creation of nuclear weapons **Properties of matter** • Have students look at different Scanning Tunneling Microscope (S.T.M.) images and relate that to properties of matter and the structure of an atom. **Atomic History** • Discuss with students present day discoveries of subatomic particles i.e. quarks, bosons, strings, etc.

Chemistry Scope & Sequence
2016-2017

Chemistry Unit 2: Quantum Effects and Periodic Trends

Essential Questions	Supporting Questions	Key Terms
• How is the frequency of emitted light related to changes in electron energy? • How does the arrangement of electrons in an atom determine the properties of that element?	• What is the relationship between energy frequency and wavelength? • What causes an atomic emission spectrum? • How do I identify an element based on its atomic emission spectrum? • How is the periodic table organized? • How do valence electrons affect the behavior of an element?	quantum, wavelength, emit, absorb, spectrum, energy level, photon, frequency, valence electron, metal, non-metal, metalloid, malleable, conductive, periodic table

Science Core Standards		Student Learning Targets
Standards	**STANDARD II: Students will understand the relationship between energy changes in the atom specific to the movement of electrons between energy levels in an atom resulting in the emission or absorption of quantum energy. They will also understand that the emission of high-energy particles results from nuclear changes and that matter can be converted to energy during nuclear reactions.** **Objective 1:** a. Identify the relationship between wavelength and light energy. b. Examine evidence from the lab indicating that energy is absorbed or released in discrete units when electrons move from one energy level to another. c. Correlate the energy in a photon to the color of light emitted. d. After observing spectral emissions in the lab (e.g., flame test, spectrum tubes), identify unknown elements by comparison to known emission spectra. **STANDARD I: Students will understand that all matter in the universe**	• I can identify the relationship between wavelength and light energy. • I can correlate the energy in a photon to the color of light emitted. • I can identify an unknown element by comparing atomic emission spectra. • I can identify the chemical behaviors of groups on the periodic table. • I can compare and contrast group trends on the periodic table. • I can predict and classify the physical properties of an element based on its location on the periodic table. • I can determine the number of valence electrons in atoms using the periodic table.

	has a common origin and is made of atoms, which have structure and can be systematically arranged on the periodic table. **Objective 3:** c. Identify similarities in chemical behavior of elements within a group. d. Generalize trends in reactivity of elements within a group to trends in other groups. e. Compare the properties of elements (e.g., metal, nonmetallic, metalloid) based on their position in the periodic table. **STANDARD III: Students will understand chemical bonding and the relationship of the type of bonding to the chemical and physical properties of substances.** **Objective 1:** a. Determine the number of valence electrons in atoms using the periodic table.	
Math Skills and/or Scientific Processing Skills		**Implementation Ideas**
Math	• Solve a one variable equation • Use appropriate units • Scientific notation • Identify patterns on a graph	• Calculate wavelength and frequency using speed of light = wavelength x frequency. • Calculate energy or frequency using energy = Planck's constant x frequency • Emphasize that units must be present in formulas ie. Hertz, meters, joules • When teaching wavelength and frequency teach students how to do scientific notation. • Describe the patterns on the first ionization vs. atomic number graph.
Literacy Standards		Literacy Implementation Ideas
Reading	**RST-4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific or technical context	• Identify the parts of the speed of light equation and energy equation (see Math implementation ideas).

	relevant to grades 9-10 texts and topics. **RST-5:** Analyze the structure of the relationships among concepts in a text, including relationships among key terms.	• Label x and y axes of a graph. • Use key terms in a sentence or note summaries. • Determine inverse and directly proportional relationships given an equation. • Using text (i.e., notes, textbook, scientific article) determine the relationship between valence electrons and reactivity.
Writing	**WHST-2d:** Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. **WHST-2e:** Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. **WHST-2f:** Provide a concluding statement or section that follows from and supports the information or explanation presented. **WHST-7:** Conduct short as well as more sustained research projects to answer a question or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.	• Interactive notebook notes, questions and summaries for daily topics (i.e. Cornell notes). • Exit ticket • Write a lab report following lab report rubric. • Summarize a scientific article. • Use sentence starters to prompt students' explanation of a teacher demonstration. • Periodic Table Element project; assign students an element and have them research it and present it to the class. Use a rubric to set clear expectations and guidelines.

Resources (labs, demonstrations, English Language Learner resources, Nature Of Science/History Of Science, or other essentials):

Quantum Effect

- Glowing pickle demo
- Atomic Emission Spectrum activity (gas tubes)
- Flame Test Lab
- Wave demos with rope or Slinkys
- Orbitron - http://winter.group.shef.ac.uk/orbitron/

Periodic Trends

- Everything in its Place – article
- Periodic Element Project
- Alkali metals in water/alkaline earths in acid demo

- Periodic table puzzle
- Websites: www.periodictable.com & www.periodicvideos.com
- "Hunting the Elements" *NOVA Science Now* video

Technology/Engineering Connections

- "Making Stuff" Videos (stronger, smaller, smarter, cleaner); *NOVA Science Now*
- Chem Matters: online source for science articles: http://www.acs.org/content/acs/en/education/resources/highschool/chemmatters.html
- Nano Materials in the Quantum World
- Graphene: the Next Wonder Material

Chemistry Scope & Sequence
2016-2017

Chemistry Unit 3: Bonding, Intermolecular Forces, and Kinetic Molecular Theory

Essential Questions	Supporting Questions	Key Terms
• How do the structures, arrangements, and forces between atoms, ions, and molecules determine the chemical and physical properties of matter?	• How do the electrostatic attractions between atoms determine the types of chemical bonds formed? • How is the type of bonding related to a substance's physical and chemical properties? • What types of intermolecular forces result from electrostatic attraction between molecules? • How does the kinetic energy of the molecules of a substance relate to the state of matter and properties of that substance?	chemical property, physical property, compound, valence electrons, ions, ionic bond, covalent bond, metallic bond, hydrogen bond, London dispersion forces, van der Waals forces, conductive, solubility, intermolecular forces, electrostatic attraction, polarity

Science Core Standards		Student Learning Targets
Standards	**Standard III. Students will understand chemical bonding and the relationship of the type of bonding to the chemical and physical properties of substances.** **Objective 1:** Analyze the relationship between the valence (outermost) electrons of an atom and the type of bond formed between atoms. a. Determine the number of valence electrons in atoms using the periodic table. b. Predict the charge an atom will acquire when it forms an ion by gaining or losing electrons. c. Predict bond types based on the behavior of valence (outermost) electrons. d. Compare covalent, ionic, and metallic bonds with respect to electron behavior and relative bond strengths. **Objective 2:** Explain that the properties of a compound may be different from those of the elements or compounds from which it is formed. a. Use a chemical formula to represent the names of elements and numbers	• I can demonstrate that covalent bonding results from the sharing of electrons due to very little difference in electronegativity. • I can demonstrate that ionic bonding results from attraction between oppositely charged ions. • I can illustrate that Metallic bonding occurs when metal nuclei are surrounded by a sea of electrons. • I can list the properties of ionic solids: high melting point, are brittle, and conduct electricity in solution. • I can list the properties of metallic solids: good conductors of heat and electricity, and are shiny, malleable, and ductile. • I can list the properties of covalent compounds: generally low melting point, and do not conduct

	of atoms in a compound and recognize that the formula is unique to the specific compound. b. Compare the physical properties of a compound to the elements that form it. c. Compare the chemical properties of a compound to the elements that form it. d. Explain that combining elements in different proportions results in the formation of different compounds with different properties. **Objective 3:** Relate the properties of simple compounds to the type of bonding, shape of molecules, and intermolecular forces. a. Generalize, from investigations, the physical properties (e.g., malleability, conductivity, solubility) of substances with different bond types. b. Given a model, describe the shape and resulting polarity of water, ammonia, and methane molecules. c. Identify how intermolecular forces of hydrogen bonds in water affect a variety of physical, chemical, and biological phenomena (e.g., surface tension, capillary action, boiling point).	electricity. • I can analyze data on properties to determine relative strength of interactions. • I can identify the type of bonding based on the properties of the substance. • I can show how the properties of different bonded compounds are important in designing materials. • I can identify the number of valence electrons an element has by its position on the periodic table. • I can determine the charge on an ion based on the element's position on the periodic table. • I can explain how molecular shapes result from valence shell electron repulsion (VSEPR). • I can determine the molecular polarity based on geometry and bond polarity. • I can relate solubility of a substance to intermolecular interactions. • I can summarize each type of intermolecular force and the types of molecules that are involved. • I can identify the type of intermolecular force based on the structure and/or properties of the molecule.
Math Skills and/or Scientific Processing Skills		**Implementation Ideas**
Math	Basic Operations (Addition, Subtraction, Multiplication), Ratios/Proportions	• Students can determine which compounds or elements have higher boiling points by examining and comparing their molar masses. • Ionic Bonding Puzzle Activity
Literacy Standards		• **Literacy Implementation Ideas**

Chemistry Scope & Sequence
2016-2017

Reading	**RST-3:** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. **RST-9:** Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.	• Ask students how they can relate conductivity and ionic compounds to the iodine deficiency disorder and to lack of fluoride. Challenge students to go further by thinking about Gatorade or PowerAde and the marketing that surrounds those products. • Students read and respond to text that illustrates how the significant bonding of H_2O leads to an appreciation of water in their bodies. Students respond to the reading by discussing how water's unique properties are a result of its bonding and reflect on how their bodies don't boil or freeze even though the temperature outside changes quite a bit.
Writing	**WHST-2f:** Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulation implications or the significance of the topic). **WHST-4:** Produce a clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. **WHST-9:** Draw evidence from informational texts to support analysis, reflection, and research.	• Students write a statement to summarize the properties of ionic compounds and another statement to summarize the properties of covalent compounds and why it is important to know the difference between ionic and covalently bonded substances. • A microwave oven works by warming food with radiation that has a frequency of about 3 GHz. Ask students to create an informational brochure or text for a webpage that explains how radiation rotates the water molecules, generating energy as heat and thereby cooking the food.
Resources (labs, demonstrations, English Language Learner resources, Nature Of Science/History Of Science, or other essentials):		
Determining the Formula of an Ionic Compound Lab Molecular Shape Lab Ionic vs. Covalent Compound Lab		

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Technology/Engineering Connections
• Students explore the use of adhesives, intermolecular forces and how biomimicry is being used by chemists to invent greener alternative products. • Computational chemistry is the study of molecules, their properties, and the interaction between molecules using mathematical equations. Computational chemists require expertise in mathematics, computers, and chemistry. Students can research how computational chemists help in the discovery of new medicines and new catalysts.

Chemistry Scope & Sequence
2016-2017

Chemistry Unit 4: Chemical Reactions, Moles, and Stoichiometry

Essential Questions	Supporting Questions	Key Terms
• How are atoms rearranged and/or electrons transferred during a chemical reaction? • How are chemical reactions represented? • Why is the mole an important measurement in chemistry? • How do you predict information about a product from information about a reactant?	• How is the law of conservation of mass illustrated in a chemical reaction? • How do chemical reactions obey the law of conservation of mass? • How can a chemical reaction be represented as a balanced chemical equation? • How are chemical reactions classified? • What physical changes provide evidence that a chemical change has occurred? • How do the properties of reactants compare to the products in a chemical reaction? • How are balanced chemical equations used in stoichiometric calculations? • How can you calculate amounts of reactants and products in a chemical reaction? • What is the sequence of steps used in solving a stoichiometric problem?	chemical reactions, reactants, products, yield, produce, law of conservation of mass, precipitate,

Science Core Standards		Student Learning Targets
Standards	**Objective 2: Relate the structure, behavior, and scale of an atom to the particles that compose it.** e. Relate the mass and number of atoms to the gram-sized quantities of matter in a mole. **Standard IV: Students will understand that in chemical reactions matter and energy change forms, but the amounts of matter and energy do not change.**	• I can determine that a chemical reaction has occurred by looking for indication of a chemical change like: transfer of energy (temperature/light), odor, gas production, formation of a precipitate (solid), unexpected change in color • I can show that mass is conserved mathematically and experimentally during the course of a chemical reaction. • I can utilize the Law of Conservation of Mass to balance equations.

Chemistry Scope & Sequence
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	Objective 1: Identify evidence of chemical reactions and demonstrate how chemical equations are used to describe them. a. Generalize evidences of chemical reactions. b. Compare the properties of reactants to the properties of products in a chemical reaction. c. Use a chemical equation to describe a simple chemical reaction. d. Recognize that the number of atoms in a chemical reaction does not change. e. Determine the molar proportions of the reactants and products in a balanced chemical reaction. f. Investigate everyday chemical reactions that occur in a student's home (e.g., baking, rusting, bleaching, cleaning). **Objective 2:** Analyze evidence for the laws of conservation of mass and conservation of energy in chemical reactions. a. Using data from quantitative analysis, identify evidence that supports the conservation of mass in a chemical reaction. b. Use molar relationships in a balanced chemical reaction to predict the mass of product produced in a simple chemical reaction that goes to completion.	• I can identify different types of chemical reactions as synthesis, decomposition, combustion, single replacement or double replacement based on the reactants and products. • I can explain how chemists count the number of atoms, molecules, or formula units in a substance. • I can determine the mass of a given number of moles of a substance • I can calculate the atomic mass and molar mass • I can convert between the number of moles & molecules of a substance • I can convert from moles to moles using molar ratio in a balanced chemical reaction
Math Skills and/or Scientific Processing Skills		Implementation Ideas
Math	• Ratios/proportions • Converting between different units • Forming ratios between products and reactants • Describing ratios between compounds in a reaction • Calculating quantities of products or reactants (in mass, moles, volume, etc.) • Scientific Notation	• Balancing equations using ratios of atoms in chemical equations • Chemical equations • Dimensional analysis • Percent Composition • Mole-Mole problems • Mole-mass problems

		• Mass-mass problems • Mole-volume problems for solutions • Mole-volume problems for gases • Limiting Reactant
	Literacy Standards	Literacy Implementation Ideas
Reading	**RST-7:** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. **RST-8:** Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.	• Have students translate a chemical equation from words into symbols or vice versa • Students read and discuss articles about fuel cell engines, internal combustion engines, and hybrid engines to compare and contrast their energy requirements.
Writing	**WHST-1:** Write arguments focused on *discipline-specific content*. **WHST-1a:** Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. **WHST-1b:** Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. **WHST-1c:** Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. **WHST-1d:** Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. **WHST-1e:** Provide a concluding statement or section that follows from or supports the argument presented.	• After reading the article(s) about types of engines (see literacy implementation idea, above) have students research all three types of engine and make an argument for which the student thinks is the best source of energy.

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Resources (labs, demonstrations, English Language Learner resources, Nature Of Science/History Of Science, or other essentials):
Candle Observation Lab www.sciencegeek.net/APchemistry/APtaters/EquationBalancing.htm http://www.fueleconomy.gov/feg/fuelcell.shtml
Technology/Engineering Connections
● copper cycle

Chemistry Scope & Sequence
2016-2017

Chemistry Unit 5: Solutions, and Acids & Bases

Essential Questions	Supporting Questions	Key Terms
• How are the concentrations of solutions determined? • How are acids and bases related to hydrogen-ion concentration?	• How are acidic, basic, and neutral solutions related to pH and pH? • How are acids and bases relevant to society and the environment?	solution, solute, solvent, concentration, molarity, percent concentration, boiling point, freezing point, acid, base, pH, indicator, titration, hydrogen ion, neutralization, parts per million, concentrated, dilute, dissolve

	Science Core Standards	Student Learning Targets
Standards	**STANDARD VI: Students will understand the properties that describe solutions in terms of concentration, solutes, solvents, and the behavior of acids and bases** **Objective 1:** Describe factors affecting the process of dissolving and evaluate the effects that changes in concentration have on solutions. a. Use the terms solute and solvent in describing a solution. b. Sketch a solution at the particle level. c. Describe the relative amount of solute particles in concentrated and dilute solutions and express concentration in terms of molarity and molality. d. Design and conduct an experiment to determine the factors (e.g., agitation, particle size, temperature) affecting the relative rate of dissolution. e. Relate the concept of parts per million (PPM) to relevant environmental issues found through research. **Objective 2:** Summarize the quantitative and qualitative effects of colligative properties on a solution when a solute is added. a. Identify the colligative properties of a solution. b. Measure change in boiling and/or freezing point of a solvent when a solute is added.	• I can classify evidence of temperature change in a chemical reaction as endothermic or exothermic. • I can diagram or draw electrochemical cell that illustrates how electrical energy can be produced in a chemical reaction. • I can use the terms solute and solvent in describing a solution. • I can sketch a solution at the particle level. • I can calculate concentration in terms of molarity. • Identify the colligative properties of a solution. • I can predict the change in a boiling and/or freezing point of a solvent when a solute is added. • I can describe how colligative properties affect the behavior of solutions in everyday applications (e.g., road salt, cold packs, antifreeze). • I can relate hydrogen ion concentration to pH values and to the terms acidic, basic or neutral. • I can use an indicator to measure the pH of common household solutions and standard laboratory solutions

	c. Describe how colligative properties affect the behavior of solutions in everyday applications (e.g., road salt, cold packs, antifreeze). **Standard VI. Students will understand the properties that describe solutions in terms of concentration, solutes, solvents, and the behavior of acids and bases.** **Objective 3:** Differentiate between acids and bases in terms of hydrogen ion concentration. a. Relate hydrogen ion concentration to pH values and to the terms acidic, basic or neutral. b. Using an indicator, measure the pH of common household solutions and standard laboratory solutions, and identify them as acids and bases. c. Determine the concentration of an acid or a base using a simple acid-base titration. d. Research and report on the uses of acids and bases in industry, agriculture, medicine, mining, manufacturing, or construction. e. e. Evaluate mechanisms by which pollutants modify the pH of various environments (e.g., aquatic, atmospheric, soil).	and identify them as acids or bases. • I can determine the concentration of an acid or a base using a simple acid-base titration. • I can research and report on the uses of acids and bases in industry, agriculture, medicine, mining, manufacturing, or construction. • I can evaluate mechanisms by which pollutants modify the pH of various environments (e.g., aquatic, atmospheric, soil).
Math Skills and/or Scientific Processing Skills		**Implementation Ideas**
Math	• Converting between different units • Forming ratios between products and reactants • Describing ratios between compounds in a reaction • Calculating quantities of products or reactants (in mass, moles, volume, etc.) • Logarithms—introduction • Scientific Notation	• Molarity • Students will demonstrate their ability to work cooperatively in groups to collect and graphically display data for testing the pH of samples with pH papers and cabbage juice indicators, identifying unknowns, and predicting % concentrations. • Students will make predictions about how a substance can be neutralized. They should make conjectures, test them, and make modifications based on new results. • Students will investigate pH values in common substances. They should then be able to communicate how this applies to everyday life. • Students will examine acids, bases, and neutral solutions found in common substances and some reasons for their use. Students will analyze data from

		testing water and rain samples.
Literacy Standards		**Literacy Implementation Ideas**
Reading	**RST-6:** Analyze the author's purpose in providing an explanation, describing a procedure, or an experiment in a text, defining the question the author seeks to address. **RST-7:** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. **RST-10:** By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.	• Students research the conditions used in the Haber Process and find out why the development of the process was of great importance. They should focus on reading explanations from two different texts so that they can compare author's purpose. • Conduct library research to find out about acid rain. Include information on the chemical reactions that create acid rain and the sources that cultivate its production. Discuss what steps are used to prevent and control the damage caused by it. • Research how to determine whether the soil around your house is acidic or basic using pH paper and the procedure obtained from your teacher. Record your results on a data table. Find one type of plant that would grow well in the type of soil around your home and one that would not grow well.
Writing	**WHST-5:** Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*). **WHST-6:** Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.	• Students explain how in an experiment they might obtain a percent yield of product of 108%. Could that be possible? Assuming that their calculation is correct, students offer reasons to explain such a result. • Students use a Google Doc to log the results of their research on how an increase or a decrease in mass transit will impact air quality. Students should include which air pollutants are produced by combustion of gasoline in internal combustion engines. They should also use stoichiometry to argue which author might have the best solution. • Students investigate tooth decay and its relationship to fluoridation. Students should also include how acids

		attack tooth enamel and how fluoridation makes enamel more resistant to acid erosion.

Resources (labs, demonstrations, English Language Learner resources, Nature Of Science/History Of Science, or other essentials):

- Additional practice questions (on paper/white boards, presented & discussed)
- Labs: Mr. Mole & the Beans, Lego Stoichiometry, Balancing Equations Using Models, Fizzy Drinks Lab, Syringe Lab, Rocket Stoichiometry Lab, Synthesis/Decomposition Lab, Bubble Gum Percent Composition, Factors Affecting Solubility, Percent Yield, Determine Mole Ratio
- Measuring pH of household items, Antacids, Titration

Technology/Engineering Connections

- Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- Investigate how automobile air bags inflate and engineer an improved inflatable air bag.
- Research how chemists determine the safe dosing level for an experimental drug. Debate how a drug's effectiveness must be balanced with its potential toxicity and side effects.
- Many insects secrete hydrogen peroxide and hydroquinone. Bombardier beetles take it a step further by mixing these chemicals with a catalyst. Students could investigate the results of such a chemical reaction and how researchers hope to use a similar method to reignite aircraft turbine engines.
- Students can describe how colligative properties affect the behavior of solutions in everyday applications and propose improvements in design for those applications (e.g., road salt, cold packs, antifreeze).
- Students research the cost of sulfuric acid and how it affects the cost of many consumer items, such as, fertilizers, detergents, pigments, and textiles.
- Investigate engineering solutions to combat ocean acidification. Students can compare/contrast the most promising innovations that will decrease the ocean's absorption of CO_2.
- Research the buffer system used to control blood pH. Students can use the information to explain why important biochemical reactions are effective only within a narrow pH range and which technologies are used to monitor blood pH.

Chemistry Scope & Sequence
2016-2017

Chemistry Unit 6: Energy, Reaction Rates, Equilibrium, and Acids and Bases

Essential Questions	Supporting Questions	Key Terms
• How does energy drive chemical reactions? • What factors affect reaction rates? • What is chemical equilibrium? • How does an electrochemical cell work?	• How can exothermic and endothermic reactions be quantified and qualified? • How can information from graphs and data be used to draw conclusions about reaction rates? • How do factors specific to collisions influence reaction rates? • What is dynamic equilibrium? • What factors impact chemical equilibrium? • How can electrical energy be produced in an electrochemical cell?	law of conservation of energy, temperature, electrochemical cell, entropy, chemical equation, endothermic, exothermic, heat, rate, catalyst, concentration, collision theory, equilibrium, law of conservation of energy, temperature, electrochemical cell, electrochemical, electrical potential, anode, cathode, volt

Science Core Standards		Student Learning Targets
Standards	**STANDARD IV: Students will understand that in chemical reactions matter and energy change forms, but the amounts of matter and energy do not change.** **Objective 2: Analyze evidence for the laws of conservation of mass and conservation of energy in chemical reactions.** c. Report evidence of energy transformations in a chemical reaction. d. After observing or measuring, classify evidence of temperature change in a chemical reaction as endothermic or exothermic. f. Using collected data, report the loss or gain of heat energy in a chemical reaction. **Standard V: Students will understand that many factors influence chemical reactions and some reactions can achieve a state of dynamic equilibrium.** **Objective 1: Evaluate factors specific to collisions (e.g., temperature, particle size, concentration, and catalyst) that**	• I can report evidence of energy transformations in a chemical reaction. • I can observe measure, and classify evidence of temperature change in a chemical reaction as endothermic or exothermic. • I can collect data and report the loss or gain of heat energy in a chemical reaction. • I can design and conduct an investigation of the factors affecting reaction rate and use the findings to generalize the results to other reactions. • I can use the information from graphs to draw warranted conclusions about reaction rates. • I can correlate frequency and energy of collisions to reaction rate. • I can identify that catalysts are effective in increasing reaction

	affect the rate of chemical change. a. Design and conduct an investigation of the factors affecting reaction rate and use the findings to generalize the results to other reactions. b. Use information from graphs to draw warranted conclusions about reaction rates. c. Correlate frequency and energy of collisions to reaction rate. d. Identify that catalysts are effective in increasing reaction rates. **Objective 2: Recognize that certain reactions do not convert all reactants to products, but achieve a state of dynamic equilibrium that can be** a. Explain the concept of dynamic equilibrium. b. Given an equation, identify the effect of adding either product or reactant to a shift in equilibrium. c. Indicate the effect of a temperature change on the equilibrium, using an equation showing a heat term.	rates. • I can explain the concept of dynamic equilibrium. • Given an equation, I can identify the effect of adding either product or reactant to a shift in equilibrium Le Chatêlier's principle. • I can indicate the effect of a temperature change on the equilibrium, using an equation showing a heat term. • I can determine which species is being oxidized (losing electrons) and which is being reduced (gaining electrons). • I can illustrate the movement of electrons in an electrochemical cell. • I can calculate the electrical potential of a voltaic cell based on reduction potentials.
Math Skills and/or Scientific Processing Skills		**Implementation Ideas**
Math	Graph Interpretation Units, dimensions, conversions	• Students will create and use data tables, box and whiskers plot and graphs to represent data. • Calculate the value using standard reduction values.
Literacy Standards		Literacy Implementation Ideas
Reading		•
Writing	**WHST-2:** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.	• Students compare and contrast several different analytic devices (portable infrared spectrophotometer, fuel cell, glass or plastic tubes with common chemical reagents) that administer Breathalyzer tests. Students should also include an explanation of the chemistry of Breathalyzer tests as well as

		the accuracy and reliability of their results. • Students write an explanation about the effects of changing the temperature or concentration of the reacting particles and the rate at which a reaction occurs. • Students refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

Resources (labs, demonstrations, English Language Learner resources, Nature Of Science/History Of Science, or other essentials):

Labs: Popcorn Gas, Factors Affecting Rate, Cobalt Chloride, Fe^{3+} ion and KSCN Reaction
Demos: Coffee Creamer particle size

Technology/Engineering Connections

- Students investigate how the electrodeposition of metals is used to form protective or decorative coatings or objects. Students could focus on depositon of copper and tin for applications in electronics and semiconductor manufacture or they could investigate the importance of protective coatings preventing corrosion.

College and Career Readiness Anchor Standards for Reading

The grades 6–12 standards on the following pages define what students should understand and be able to do by the end of each grade span. They correspond to the College and Career Readiness (CCR) anchor standards below by number. The CCR and grade-specific standards are necessary complements—the former providing broad standards, the latter providing additional specificity—that together define the skills and understandings that all students must demonstrate.

Key Ideas and Details

1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
2. Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.
3. Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

Craft and Structure

4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.
5. Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.
6. Assess how point of view or purpose shapes the content and style of a text.

Integration of Knowledge and Ideas

7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.*
8. Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.
9. Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

Range of Reading and Level of Text Complexity

10. Read and comprehend complex literary and informational texts independently and proficiently.

*Please see "Research to Build and Present Knowledge" in Writing for additional standards relevant to gathering, assessing, and applying information from print and digital sources.

Note on range and content of student reading

Reading is critical to building knowledge in history/social studies as well as in science and technical subjects. College and career ready reading in these fields requires an appreciation of the norms and conventions of each discipline, such as the kinds of evidence used in history and science; an understanding of domain-specific words and phrases; an attention to precise details; and the capacity to evaluate intricate arguments, synthesize complex information, and follow detailed descriptions of events and concepts. In history/social studies, for example, students need to be able to analyze, evaluate, and differentiate primary and secondary sources. When reading scientific and technical texts, students need to be able to gain knowledge from challenging texts that often make extensive use of elaborate diagrams and data to convey information and illustrate concepts. Students must be able to read complex informational texts in these fields with independence and confidence because the vast majority of reading in college and workforce training programs will be sophisticated nonfiction. It is important to note that these Reading standards are meant to complement the specific content demands of the disciplines, not replace them.

Reading Standards for Literacy in Science and Technical Subjects 6–12

RST

Grades 6–8 students:	Grades 9–10 students:	Grades 11–12 students:
Key Ideas and Details		
1. Cite specific textual evidence to support analysis of science and technical texts.	1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.	1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
2. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.	2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.	2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.	3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.	3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
Craft and Structure		
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.*	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 9–10 texts and topics*.	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 11–12 texts and topics*.
5. Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.	5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).	5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.	6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.	6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
Integration of Knowledge and Ideas		
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).	7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.	7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
8. Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.	8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.	8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.	9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.	9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
Range of Reading and Level of Text Complexity		
10. By the end of grade 8, read and comprehend science/technical texts in the grades 6–8 text complexity band independently and proficiently.	10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.	10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.

College and Career Readiness Anchor Standards for Writing

The grades 6–12 standards on the following pages define what students should understand and be able to do by the end of each grade span. They correspond to the College and Career Readiness (CCR) anchor standards below by number. The CCR and grade-specific standards are necessary complements—the former providing broad standards, the latter providing additional specificity—that together define the skills and understandings that all students must demonstrate.

Text Types and Purposes*

1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.
2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details and well-structured event sequences.

Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
8. Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.
9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

*These broad types of writing include many subgenres. See Appendix A for definitions of key writing types.

Note on range and content of student writing

For students, writing is a key means of asserting and defending claims, showing what they know about a subject, and conveying what they have experienced, imagined, thought, and felt. To be college and career ready writers, students must take task, purpose, and audience into careful consideration, choosing words, information, structures, and formats deliberately. They need to be able to use technology strategically when creating, refining, and collaborating on writing. They have to become adept at gathering information, evaluating sources, and citing material accurately, reporting findings from their research and analysis of sources in a clear and cogent manner. They must have the flexibility, concentration, and fluency to produce high-quality first-draft text under a tight deadline and the capacity to revisit and make improvements to a piece of writing over multiple drafts when circumstances encourage or require it. To meet these goals, students must devote significant time and effort to writing, producing numerous pieces over short and long time frames throughout the year.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6–12

WHST

The standards below begin at grade 6; standards for K–5 writing in history/social studies, science, and technical subjects are integrated into the K–5 Writing standards. The CCR anchor standards and high school standards in literacy work in tandem to define college and career readiness expectations—the former providing broad standards, the latter providing additional specificity.

Grades 6–8 students:	Grades 9–10 students:	Grades 11–12 students:
Text Types and Purposes		
1. Write arguments focused on *discipline-specific content*. a. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically. b. Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources. c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence. d. Establish and maintain a formal style. e. Provide a concluding statement or section that follows from and supports the argument presented.	1. Write arguments focused on *discipline-specific content.* a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.	1. Write arguments focused on *discipline-specific content.* a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases. c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6–12

WHST

Grades 6–8 students:	Grades 9–10 students:	Grades 11–12 students:
Text Types and Purposes (continued)		
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples. c. Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Establish and maintain a formal style and objective tone. f. Provide a concluding statement or section that follows from and supports the information or explanation presented.	2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).	2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
3. (See note; not applicable as a separate requirement)	3. (See note; not applicable as a separate requirement)	3. (See note; not applicable as a separate requirement)

Note: Students' narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6–12

WHST

Grades 6–8 students:	Grades 9–10 students:	Grades 11–12 students:
Production and Distribution of Writing		
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5. With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.	5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.	5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
6. Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.	6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.	6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
Research to Build and Present Knowledge		
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.	7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.	7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
8. Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.	8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.	8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
9. Draw evidence from informational texts to support analysis reflection, and research.	9. Draw evidence from informational texts to support analysis, reflection, and research.	9. Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing		
10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.	10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.	10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Performance Definitions for the Levels of English Language Proficiency in Grades K-12

At the given level of English language proficiency, English language learners will process, understand, produce, or use:

6 Reaching	• specialized or technical language reflective of the content areas at grade level • a variety of sentence lengths of varying linguistic complexity in extended oral or written discourse as required by the specified grade level • oral or written communication in English comparable to English-proficient peers
5 Bridging	• specialized or technical language of the content areas • a variety of sentence lengths of varying linguistic complexity in extended oral or written discourse, including stories, essays, or reports • oral or written language approaching comparability to that of English-proficient peers when presented with grade-level material
4 Expanding	• specific and some technical language of the content areas • a variety of sentence lengths of varying linguistic complexity in oral discourse or multiple, related sentences, or paragraphs • oral or written language with minimal phonological, syntactic, or semantic errors that do not impede the overall meaning of the communication when presented with oral or written connected discourse with sensory, graphic, or interactive support
3 Developing	• general and some specific language of the content areas • expanded sentences in oral interaction or written paragraphs • oral or written language with phonological, syntactic, or semantic errors that may impede the communication, but retain much of its meaning, when presented with oral or written, narrative, or expository descriptions with sensory, graphic, or interactive support
2 Beginning	• general language related to the content areas • phrases or short sentences • oral or written language with phonological, syntactic, or semantic errors that often impede the meaning of the communication when presented with one- to multiple-step commands, directions, questions, or a series of statements with sensory, graphic, or interactive support
1 Entering	• pictorial or graphic representation of the language of the content areas • words, phrases, or chunks of language when presented with one-step commands, directions, WH-, choice, or yes/no questions, or statements with sensory, graphic, or interactive support • oral language with phonological, syntactic, or semantic errors that often impede meaning when presented with basic oral commands, direct questions, or simple statements with sensory, graphic, or interactive support

Grade Level Cluster Can Do Descriptors

The grade level cluster Can Do Descriptors have been created by teachers, primarily for teachers, who work with English language learners throughout the consortium. During 2007-08, over 900 teachers and administrators participated in refining and validating five grade level clusters of Descriptors from the original document spanning the K-12 spectrum. These Descriptors for the four language domains—listening, speaking, reading, and writing—and five levels of English language proficiency are based on the WIDA English Language Proficiency Standards.

Interpretation of the Can Do Descriptors
To maintain the succinctness of the individual statements, some basic assumptions need to be made in interpreting the Can Do Descriptors.

1. Sensory, graphic, or interactive support are present through language proficiency level 4, Expanding.
2. English language learners can process or produce the **language** associated with the stated language functions.
3. Linguistic complexity, vocabulary usage, and language control increase incrementally as students move from one English language proficiency level to the next.

The Can Do Descriptors are a sampling of the language expectations of English language learners as they travel along the continuum of English language development. Unlike the strands of model performance indicators that scaffold across levels of language proficiency, the Can Do Descriptors function independently within a given level of language proficiency.

Uses for the Can Do Descriptors

The Can Do Descriptors are a resource, in addition to the English language proficiency standards, to use in classrooms with English language learners. As an instructional assessment tool, language teachers may:

- Share the Descriptors with classroom teachers and administrators to describe the second language acquisition process around the levels of English language proficiency
- Provide resource teachers, such as Title I or literacy coaches, additional information about English language learners
- Use to plan with tutors or mentors who work with English language learners
- Develop or co-develop lessons and units of study with differentiated language objectives
- Set language goals with their English language learners*
- Explain to parents students' progress in listening, speaking, reading, and writing*
- Suggest language goals to be incorporated into Individual Education Programs (IEPs) for English language learners with diagnosed disabilities
- Translate English language proficiency test scores (i.e., ACCESS for ELLs®, W-APT™, and WIDA MODEL™) into classroom practice
- Observe and note levels of student performance as a precursor to using WIDA Speaking and Writing Rubrics for formative assessment
- Use the Descriptors to advocate on behalf of English language learners

** For these uses, the Can Do Descriptors are also available in Spanish on pp. 8-11 of this booklet.*

Can Do Descriptors: Grade Level Cluster 9-12

For the given level of English language proficiency and with visual, graphic, or interactive support through Level 4, English language learners can process or produce the **language** needed to:

	Level 1 Entering	Level 2 Beginning	Level 3 Developing	Level 4 Expanding	Level 5 Bridging	Level 6 - Reaching
LISTENING	• Point to or show basic parts, components, features, characteristics, and properties of objects, organisms, or persons named orally • Match everyday oral information to pictures, diagrams, or photographs • Group visuals by common traits named orally (e.g., "These are polygons.") • Identify resources, places, products, figures from oral statements, and visuals	• Match or classify oral descriptions to real-life experiences or visually-represented, content-related examples • Sort oral language statements according to time frames • Sequence visuals according to oral directions	• Evaluate information in social and academic conversations • Distinguish main ideas from supporting points in oral, content-related discourse • Use learning strategies described orally • Categorize content-based examples described orally	• Distinguish between multiple meanings of oral words or phrases in social and academic contexts • Analyze content-related tasks or assignments based on oral discourse • Categorize examples of genres read aloud • Compare traits based on visuals and oral descriptions using specific and some technical language	• Interpret cause and effect scenarios from oral discourse • Make inferences from oral discourse containing satire, sarcasm, or humor • Identify and react to subtle differences in speech and register (e.g., hyperbole, satire, comedy) • Evaluate intent of speech and act accordingly	
SPEAKING	• Answer yes/no or choice questions within context of lessons or personal experiences • Provide identifying information about self • Name everyday objects and pre-taught vocabulary • Repeat words, short phrases, memorized chunks of language	• Describe persons, places, events, or objects • Ask WH- questions to clarify meaning • Give features of content-based material (e.g., time periods) • Characterize issues, situations, regions shown in illustrations	• Suggest ways to resolve issues or pose solutions • Compare/contrast features, traits, characteristics using general and some specific language • Sequence processes, cycles, procedures, or events • Conduct interviews or gather information through oral interaction • Estimate, make predictions or pose hypotheses from models	• Take a stance and use evidence to defend it • Explain content-related issues and concepts • Compare and contrast points of view • Analyze and share pros and cons of choices • Use and respond to gossip, slang, and idiomatic expressions • Use speaking strategies (e.g., circumlocution)	• Give multimedia oral presentations on grade-level material • Engage in debates on content-related issues using technical language • Explain metacognitive strategies for solving problems (e.g., "Tell me how you know it.") • Negotiate meaning in pairs or group discussions	

The Can Do Descriptors work in conjunction with the WIDA Performance Definitions of the English language proficiency standards. The Performance Definitions use three criteria (1. linguistic complexity; 2. vocabulary usage; and 3. language control) to describe the increasing quality and quantity of students' language processing and use across the levels of language proficiency.

Can Do Descriptors: Grade Level Cluster 9-12

For the given level of English language proficiency and with visual, graphic, or interactive support through Level 4, English language learners can process or produce the **language** needed to:

	Level 1 Entering	Level 2 Beginning	Level 3 Developing	Level 4 Expanding	Level 5 Bridging	Level 6 - Reaching
READING	• Match visual representations to words/phrases • Read everyday signs, symbols, schedules, and school-related words/phrases • Respond to WH- questions related to illustrated text • Use references (e.g., picture dictionaries, bilingual glossaries, technology)	• Match data or information with its source or genre (e.g., description of element to its symbol on periodic table) • Classify or organize information presented in visuals or graphs • Follow multi-step instructions supported by visuals or data • Match sentence-level descriptions to visual representations • Compare content-related features in visuals and graphics • Locate main ideas in a series of related sentences	• Apply multiple meanings of words/phrases to social and academic contexts • Identify topic sentences or main ideas and details in paragraphs • Answer questions about explicit information in texts • Differentiate between fact and opinion in text • Order paragraphs or sequence information within paragraphs	• Compare/contrast authors' points of view, characters, information, or events • Interpret visually- or graphically-supported information • Infer meaning from text • Match cause to effect • Evaluate usefulness of data or information supported visually or graphically	• Interpret grade-level literature • Synthesize grade-level expository text • Draw conclusions from different sources of informational text • Infer significance of data or information in grade-level material • Identify evidence of bias and credibility of source	
WRITING	• Label content-related diagrams, pictures from word/phrase banks • Provide personal information on forms read orally • Produce short answer responses to oral questions with visual support • Supply missing words in short sentences	• Make content-related lists of words, phrases, or expressions • Take notes using graphic organizers or models • Formulate yes/no, choice and WH- questions from models • Correspond for social purposes (e.g., memos, e-mails, notes)	• Complete reports from templates • Compose short narrative and expository pieces • Outline ideas and details using graphic organizers • Compare and reflect on performance against criteria (e.g., rubrics)	• Summarize content-related notes from lectures or text • Revise work based on narrative or oral feedback • Compose narrative and expository text for a variety of purposes • Justify or defend ideas and opinions • Produce content-related reports	• Produce research reports from multiple sources • Create original pieces that represent the use of a variety of genres and discourses • Critique, peer-edit and make recommendations on others' writing from rubrics • Explain, with details, phenomena, processes, procedures	

The Can Do Descriptors work in conjunction with the WIDA Performance Definitions of the English language proficiency standards. The Performance Definitions use three criteria (1. linguistic complexity; 2. vocabulary usage; and 3. language control) to describe the increasing quality and quantity of students' language processing and use across the levels of language proficiency.

Canyons School District
Scientific Practices

Critical Features of Instruction

SCIENTIFIC PROCESS SKILLS

Laboratory Skills
Use CSD Lab Report Expectations

1. Before a Lab

Connect Conceptual Understanding with Experiment (Pre-Lab Activities)

- Activate Prior Knowledge
- Build Background Knowledge
- Text Overview/Scavenger Hunt/Surveying the Text
- Connecting Visuals to the Surrounding Text
- Pre-Lab Readings
- Pre-Lab Quiz
- Pre-teach Text-Related Vocabulary and Academic Vocabulary (Key Terms)
    - Key Terms
    - Academic Vocabulary
    - Text-Specific Vocabulary
    - Derivational/Roots
    - Word Patterns & Word Parts

Organize for Success in the Lab

- Assign & Rotate Lab Group Responsibilities
- Write Lab Introduction
    - Identify Independent & Dependent Variables
    - Hypotheses & Procedures
    - Discussion of Theories/Concepts
- Gallery Walk

2. During a Lab

- Collect data
    - Draw Pictures
    - Create Data Tables
- Discuss findings with lab groups
- Analyze Data
- Write Conclusions

3. After a Lab

- Evaluate Student Data & Completed Lab Write Ups
- Strategic Cross-Group Partnering (Think-Pair-Share)
- Presentations
    - Mini Poster Sessions
    - PowerPoints/Prezi
    - Gallery Walk
- Reciprocal Teaching
- 30 Second Experts

Mathematical and Computational Skills

1. Follow the Explicit Instruction Model

- I do
- We do
- You all do
- You do

2. Teach and practice estimation skills

- Predict an answer prior to working out a problem
- Compare prediction (theoretical) with actual (experimental) answer

3. Require units of measurement

- Always use metric system; measurements are meaningless without units
- Scientific notation
- Attend to precision, accuracy, and measurement of error

4. Analyze data using grade appropriate statistical skills

- 6^{th} Grade
    - Understand that a set of data has a distribution which can be described by its center, spread, and overall shape
    - Display numerical data; (number line, histograms, box plots)
    - Calculate median/mean & interquartile range
- 7^{th} Grade
    - Make Inferences
    - Importance of Random Sampling
    - Explore variation in estimates or predictions in data sets
    - Use visual representations to compare/contrast numerical data
    - Understand that 1 = 100%
    - Use the results of an experiment to estimate the probability of an event
    - Compare theoretical vs. experimental probability (what is the probability of a family with five children having exactly two boys?)
- 8^{th} Grade
    - Collect, record and construct a set of vicariate data using a scatter plot
    - Determine whether relationships are linear, or nonlinear using a scatter plot
    - Interpret patterns on a scatter plot.
    - Create a line of best fit with a set of data points
    - Judge how well a trend line fits a set of data points
    - Interpret the meaning of the slopes as a rate of change

5. Building Mastery

- Fluency
- Automaticity
- Distributed Practice

Critical Features of Instruction

READING IN SCIENCE

Comprehension
General Guidelines for Close Reading:

1. Before Reading

- Select appropriate text
- Activate Prior Knowledge
- Build Background Knowledge
- Think Alouds
- Graphic Organizers
- Concept Talk
- Essential Question
- Concept Map (Storyboard)
- 30 Second Expert
- Quick Write
- Text Overview/Scavenger Hunt/Surveying the Text
- Connecting Visuals to the Surrounding Text
- Predict the Main Idea
- Questioning
- Agree or Disagree
- Pre-teach Text-Related Vocabulary and Academic Vocabulary (Key Terms)
    - Key Terms
    - Academic Vocabulary
    - Text-Specific Vocabulary
    - Derivational/Roots
    - Word Patterns & Word Parts

2. During Reading

Active Reading Strategies Help Students:

- Summarize
- Analyze, Synthesize & Evaluate
- Compare & Contrast

Active Reading Strategies:

- Note-taking
    - Skeletal Notes
    - Cornell Notes
    - Double-Entry Journal
- Vocabulary Strategies
    - Read-forward
    - Context Clues
    - Figurative & Connotative Meanings
- Annotation
    - Marking Text
    - Writing in the Margins
    - Charting the Text
- General Strategies
    - Cite Textual Evidence
    - Text Features & Structure (how to use a textbook)
    - Using Fix-Up Strategies (SQ3R, Monitor Comprehension, Reading-Reflection Pauses, Stop/Draw)
    - Four Corners
- Graphic Organizers
- Collaborative Reading Strategies
    - Reciprocal Teaching
    - Interactive Reading Guides
    - Strategic Partnering

3. After Reading

- Assign group work
- Cite Textual Evidence
- Text Features and Structure
- Using Fix-Up Strategies (SQ3R, Monitor Comprehension, Reading-Reflection Pauses, Stop/Draw)
- Socratic Seminar
- Strategic Partnering (Think-Pair-Share)
- Presentations
    - Interviews
    - Blogs
    - Wikis
    - Speech
    - PowerPoint/Prezi
- Cite Textual Evidence
- Reciprocal Teaching
- 30 Second Expert
- Gallery Walk
- Learning Logs

TEXT TYPES

Literary Text	Informational Text
Fiction	Exposition
Literary Nonfiction	Argumentation
Poetry	Procedural

Critical Features of Instruction
Student Writing Recorded in Interactive Notebooks/Engineering Journals

WRITING IN SCIENCE

Interactive Notebooks

- Right Side = Student Input
  - Notes from a lecture/guest speaker
  - Text or other source
  - Vocabulary words
  - Video and film notes
  - Procedures
  - Readings
  - Questions and answers
  - Sample problems
- Left Side = Student Output
  - Brainstorming
  - Student generated concept maps/graphic organizers
  - Student questions
  - Student illustrations
  - Student annotations
  - Student generated poetry/songs/etc.
  - Evidence for own reasoning
  - Student generated data and graphs
  - Student generated analysis Writing
  - Student responses to writing prompts

Writing to Learn/Demonstrate Knowledge

- Quick write
  - Bell Ringers
  - Starters
  - Exit Tickets
- Graphic Organizers (Venn diagram, webbing, KWL, T-chart)
- Concept mapping
- Anticipation Guide (pre-reading, pre-speaking, pre-listening)
- Gallery walk/Carousel
- Learning Logs
- Summarizing
- Cornell Notes
- Formal/Informal Lab Reports
- Lab Reports
- Sentence Starters
- Prompts
- 5 W's + H
- Observation vs. Inference
- GIST Summary
- Cause and Effect
- Timelines
- Biographies of scientists/engineer

Writing Process for Formal Scientific Writing/Sustained Writing

1. Before Writing

Prewrite (Individual and Collaborative)

- Choose Audience, Purpose, and Form
- Rubric Preview
- View and Analyze Student Examples
- Reading and Research
  - Cornell Notes
  - Outlines
  - Listing & Grouping
  - Graphic Organizers
  - Discussion, Guided Critiques
  - Anticipatory Guide
  - Speculation/Predictions
  - Summarizing
- Planning
  - Outlining
  - Quick writing
  - Gallery Walk
  - Graphic Organizers
  - Timelines
  - T-charts

2. During Writing

Draft (Individual and Collaborative)

- Whole Class Draft
- Small Group Draft
- Filling in the outline

Reader Response (Individual and Collaborative)

- Verbal Response
- Verbal Response Small Group
- Written Response Peer
- Pass the paper

Edit (Individual and Collaborative)

- Editing Journal
- Expert Group Editing
- Pass the paper

3. After Writing

Final Draft Publishing (Individual and Collaborative)

- Self Evaluation and Reflection

WRITING TYPES

Argument	Informative/Explanatory	Narrative
Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. *Use: controversial scientific topics, debate, & socratic seminar*	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. *Use: writing a paragraph to explain data table or chart, explaining a scientific process, summarize an article, writing a research paper*	Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences. *Use: Turn a timeline of events into a fictional story, RAFT Paper, writing a story/poem/play/song about a scientific concept, etc.*

CSD LAB REPORT EXPECTATIONS

A lab report should be seen as an argument or persuasive document. It should lead your reader through data and analysis to the same conclusions that you reach at the end of your report. To do this, you should present information in a logical and readable manner. Do not assume that your reader knows the procedure, the background concepts or the questions provided in the lab handouts, if one is given to you.

Each lab report should include the following:

Introduction	**TITLE** Appropriately title your lab as per teacher instruction.
	PURPOSE This section should describe the purpose or the problem and be in paragraph form. It should also include relevant background information and why the lab activity is important.
	VARIABLES An *independent variable* is the variable that is changed in a scientific experiment to test the effects on the *dependent variable*.
	HYPOTHESIS To construct a hypothesis, express what you think will be the effect of the independent variable on the dependent variable. This should be a cause and effect statement like the one below: As the *independent variable describe how you change it*, the *dependent variable* will *describe the effect*. Example: As the diameter of a cars tires increase, the maximum speed of the car will decrease.
	PROCEDURE This section should include a short paragraph describing the steps involved in the lab. Steps must be written in sentence form (no lists) and must not contain "we," "I," "us," etc.
Data & Observations	**DATA COLLECTION** This section should all data collected. In most cases, data should be presented in a table. Make sure that all column headings include units for all data and calculations. Recorded data and calculations should use the appropriate number of significant figures based on the precision of the measurement tools used. Any qualitative (descriptive) observations should be written in complete sentences.
	GRAPHS This section should include a visual representation of the data collected from your experiment. There are many types of graphs that could be used, such as bar graphs, histograms, scatter plots, line graphs, pie charts, etc. Graphs should have an appropriate title, labeled axes, and display an appropriate scale.

<table>
<tr><td rowspan="3">Analysis</td><td>This section should include finished calculations and answers to lab questions. Be sure to use complete sentences and, in general, make the answers as clear and readable as possible. Assume that your reader does not know what analysis questions are posed in your lab handout. Include enough of the question in your analysis so that your reader knows what you are discussing without having to read the questions.</td></tr>
<tr><td>CALCULATIONS
This section should include the work for your calculations, including equations, units, and appropriate number of significant figures. Your work should be easy to follow and be done in a logical manner. A quick glance at this section by the reader should indicate each step of your calculations. Include at least one sample calculation of each type. Show calculations mathematically instead of in paragraph form.</td></tr>
<tr><td>UNCERTAINTY AND EXPERIMENTAL ERROR (When Appropriate)
Observations and experiments involving numerical measurements have some degree of error or uncertainty. When completing the analysis section of your lab, you must bear in mind possible error and limitations of measurement. What tools were used for measurement? How accurate are they? How precisely can they be read? How do your results compare to theory given the limitations of the tools and procedures used? You need to estimate what is a reasonable level of experimental error in your results. In addition to explaining the source of error, you should note how significant each error is. Whenever possible, quantify the effect that the error had on your data or results. There should be evidence of the errors, so state the evidence. Don't list everything the might possibly have gone wrong with the experiment.

Numerical methods of estimating error include the following:

Absolute error is the difference between a measured or observed value and the accepted value. The quantity is normally expressed as a percentage, and is usually called percentage error. It is calculated as follows:
$$\text{Percentage error} = \frac{\text{accepted value} - \text{measured value}}{\text{accepted value}} \times 100\%$$

Relative error. Sometimes, if two or more values of the same quantity are measured, it is useful to calculate how close they are to each other by calculating the percentage difference between them. This quantity represents a measure of relative error and is calculated as follows:
$$\text{Percentage difference} = \frac{\text{difference in measurements}}{\text{average measurement}} \times 100\%$$</td></tr>
<tr><td>Conclusion</td><td>This section of your lab report is the concluding statement of your argument. It should be written in paragraph formatting and include the following:
Restatement of the purpose of the lab
A brief account of what you did and how it came out
State whether hypothesis was correct or incorrect
Use data from the lab to support your claim
Describe relationships that were observed
Discuss problems encountered in the experiment if appropriate
List suggestions for further study</td></tr>
</table>

LAB REPORT RUBRIC

Title	1 Point		0 Points	
	Appropriate title included in report.		No title included in report	
Introduction	**3 Points**	**2 Points**	**1 Point**	**0 Points**
	Introduction is in paragraph form, describes purpose, gives hypothesis, and shares detailed background information (at least 3 pieces).	Introduction is in paragraph form, describes purpose, and gives hypothesis, but does not provide enough background information.	Introduction is in paragraph form and either describes purpose or give hypothesis.	Introduction shares no relevant information or is not in paragraph form.
Procedure	**3 Points**	**2 Points**	**1 Point**	**0 Points**
	Steps are in paragraph form and written as full sentences (no listing), and there are no "I" statements.	Steps are in paragraph form and written as full sentences (no listing).	Steps are in paragraph form, but some procedures are listed.	Procedure exists entirely in list form, or lacks specificity.
Data	**5 Points**	**3 Points**	**1 Point**	**0 Points**
	Data tables and graph are included with all aspects labeled; information graphed is relevant, neat, and concise.	Data tables and graphs are included, but have missing labels, or lack of relevance and neatness.	Data table or graph not included.	No table or graphs included.
Analysis	**3 Points**	**2 Points**	**1 Point**	**0 Points**
	Analysis is in paragraph form and includes detailed and correct description of data (be sure to mention at least three data values); research used to support analyses. Experimental error calculated when appropriate	Analysis is in paragraph form with detailed description of data. Experimental error calculated when appropriate	Analysis is in paragraph form with very little detail in description of data.	Analysis is not in paragraph form or no description of data.
Conclusion	**3 Points**	**2 Points**	**1 Point**	**0 Points**
	Conclusion is in paragraph form with description of hypothesis result, reasons/explanation why results occurred using data points as evidence	Conclusion is in paragraph form with description of hypothesis results, reason results were occurred doesn't include appropriate data points	Conclusion is in paragraph form with description of hypothesis result included.	No appropriate conclusion given.
Works Cited	**1 Point**		**0 Points**	
	Appropriate bibliographical information included with at least 2 sources used.		No bibliographical information included.	