KNWB: Knowledge Base			
Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise and extend this knowledge. Science knowledge has a history that includes the refinement of, and changes to, theories, ideas and beliefs over time. Each student could learn a different base of knowledge. The knowledge base is founded in understanding scientific terms, facts, concepts, principles, theories and methods.			
Novice **1 – 2**	**Intermediate** **3**	**Intermediate** **4**	**Expert** **5 – 6**
• Descriptions of scientific terms, facts, concepts, principles, theories and methods are minimal, missing, incomplete and/or incorrect.	• Descriptions of scientific terms, facts, concepts, principles, theories and methods are somewhat complete and correct.	• Descriptions of scientific terms, facts, concepts, principles, theories and methods are mostly complete and correct.	• Descriptions of scientific terms, facts, concepts, principles, theories and methods are complete and correct.

<table>
<tr><th colspan="4">SEP1: Asking Questions and Defining Problems</th></tr>
<tr><td colspan="4">A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify ideas.</td></tr>
<tr><th>Novice
1 – 2</th><th>Intermediate
3</th><th>Intermediate
4</th><th>Expert
5 – 6</th></tr>
<tr><td>• Asks general, imprecise questions that require greater specificity to be testable.
• Identifies dependent and independent variables with unclear predicted relationships.
• Identifies inappropriate control(s) and/or inappropriate model(s).
• Defines a problem or design statement that partially matches the intent of the problem of the constraints.</td><td>• Asks testable questions that require sufficient and relevant evidence to answer.
• Identifies relationships between dependent and independent variables with minor errors.
• Identifies control(s) OR relationships in the relevant model(s) with minor errors of omissions.
• Defines a problem or design statement that matches the intent of the problem and identifies the constraints.</td><td>• Asks precise, testable questions that require sufficient and relevant evidence to answer.
• Discusses predicted relationships between dependent and independent variables.
• Identifies appropriate control(s) OR relationships in the relevant model(s).
• Defines a problem and explains specific design elements necessary for a suitable design (e.g., fit to the problem, addresses the constraints, etc.).</td><td>• Asks precise, testable questions that require sufficient and relevant evidence to answer and evaluates the testability of the questions.
• Discusses predicted relationships, including quantitative relationships, between dependent and independent variables and appropriate controls.
• Thoroughly explains the predicted relationships in the relevant model(s).
• Defines a problem precisely and thoroughly explains why specific design elements are necessary for a suitable design (addresses the constraints, etc.).</td></tr>
</table>

SEP2: Developing and Using Models			
A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.			
Novice **1 – 2**	**Intermediate** **3**	**Intermediate** **4**	**Expert** **5 – 6**
• Designs and explains a model that generates data to support explanations, predict phenomena, analyze systems and/or solve problems. Design or explanation of the model includes major errors or omissions. • Uses or tests the model and identifies the limitations OR accuracy of the model (with minor errors or omissions) to support explanations, predict phenomena, analyze systems or solve problems. • Explanation or evaluation of the model includes major errors or omissions.	• Designs and explains a model that generates data to support explanations, predict phenomena, analyze systems and/or solve problems. Design or explanation of the model includes minor errors or omissions. • Uses or tests the model and evaluates the accuracy and limitations of the model to support explanations, predict phenomena, analyze systems or solve problems. • Explanation or evaluation of model includes minor errors or omissions.	• Designs and explains a model that generates data to support explanations, predict phenomena, analyze systems and/or solve problems. • Uses or tests the model and evaluates the accuracy and limitations of the model to support explanations, predict phenomena, analyze systems or solve problems. • Makes reasonable recommendations to revise the model.	• Designs, explains and evaluates a model to generate data to support explanations, predict phenomena, analyze systems and/or solve problems. • Uses or tests two different models of the same proposed tool, process, mechanism or system. • Evaluates the accuracy and limitations of the two different models in order to select a model that best fits the evidence or design criteria.

SEP3: Planning and Carrying Out Investigations			
Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters. Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions.			
Novice 1 – 2	**Intermediate 3**	**Intermediate 4**	**Expert 5 – 6**
• Designs an investigation that will produce relevant data but with minimal detail about the variables. • Includes incomplete description of data collection procedures that impede replication. • Describes general evidence to be used to answer the question(s) with minimum detail. • Uses appropriate scientific methods and collects multiple trials (if appropriate) of relevant data but the data is not consistent within a reasonable range.	• Designs an investigation identifying dependent, independent and control variables. • Includes data collection procedures that are mostly replicable. • Identifies tools/instruments and types of measurements that will produce relevant data and/or evidence to answer the question(s). • Uses appropriate scientific methods and collects multiple trials (if appropriate) of relevant data consistent within a reasonable range.	• Designs an investigation identifying and explaining the dependent, independent and control variables. • Includes sufficiently detailed description of replicable data collection procedures. • Describes tools/instruments and types of measurements that will produce relevant data and/or evidence to answer the question(s). • Uses appropriate scientific methods and systematically collects multiple trials (if appropriate) of relevant data consistent within a reasonable range. • Evaluates the consistency (precision) of the data.	• Designs and evaluates an investigation identifying and explaining the dependent, independent and control variables. • Identifies possible confounding variables. • Includes thorough description of replicable data collection procedures. • Justifies the selection of the tools/instruments and types of measurements that will produce relevant data and/or evidence to answer the question(s). • Uses appropriate scientific methods and systematically collects multiple trials (if appropriate) of relevant data consistent within a narrow range. • Evaluates the consistency (precision) of the data as well as the appropriateness of the data collection procedures.

SEP4: Analyzing and Interpreting Data			
Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis. Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.			
Novice **1 – 2**	**Intermediate** **3**	**Intermediate** **4**	**Expert** **5 – 6**
• Attempts to analyze data using tools, technologies, computational and/or mathematical models in order to identify patterns, to make scientific claims or to determine an optimal design solution. Analysis or explanation includes major errors or omissions. • Identifies the limitations of the data analysis (e.g., measurement error, sample selection) with incomplete or inaccurate elements.	• Analyzes and explains data using tools, technologies, computational and/or mathematical models in order to identify patterns, to make reasonable scientific claims or to determine an optimal design solution. Analysis of explanation includes minor errors of omissions. • Identifies the limitations of the data analysis (e.g., measurement error, sample selection).	• Analyzes and explains data using tools, technologies, computational and/or mathematical models in order to identify patterns, to make reasonable scientific claims or to determine an optimal design solution. • Evaluates the limitations of the data analysis (e.g., measurement error, sample selection) and identifies some implications for the findings.	• Analyzes and explains data using tools, technologies, computational and/or mathematical models in order to identify patterns, to make reasonable and well supported scientific claims or to determine an optimal design solution. • Thoroughly evaluates the limitations of data analysis (e.g., measurement error, sample selection) and provides a detailed explanation of the implications on the findings.

SEP5: Using Mathematics and Computational Thinking			
In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions.			
Novice **1 – 2**	**Intermediate** **3**	**Intermediate** **4**	**Expert** **5 – 6**
• Identifies mathematical concepts or methods (e.g., ratio, rate, percent, basic operations, algebra and functions) relevant to scientific questions or engineering problems, but applies them with major errors or omissions.	• Applies appropriate mathematical concepts or methods (e.g., ratio, rate, percent, basic operations, algebra and functions) relevant to scientific questions or engineering problems, but applies them with minor errors or omissions.	• Accurately applies appropriate mathematical concepts and methods (e.g., ratio, rate, percent, basic operations, algebra and functions) to answer scientific questions or engineering problems.	• Accurately applies appropriate mathematical concepts and methods (e.g., ratio, rate, percent, basic operations, algebra and functions) to represent and solve scientific questions or engineering problems and explains whether the answer "makes sense".

SEP6: Constructing Explanations and Designing Solutions			
The end-products of science are explanations and the end-products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories. The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.			
Novice **1 – 2**	**Intermediate** **3**	**Intermediate** **4**	**Expert** **5 – 6**
• Proposes a design plan and description that misses one or more important aspects of the criteria, constraints OR intent of the problem. • Uses inaccurate or irrelevant evidence (data or scientific knowledge) to explain how the design addresses the problem, constraints OR identifies an impractical redesign without explanation or supporting evidence.	• Proposes a design plan and provides a general description that addresses the criteria, constraints, or intent of the problem. • Uses minimal relevant evidence (data or scientific knowledge) to explain how the design addresses the problem, constraints OR identifies a potential redesign with limited explanation and supporting evidence.	• Proposes a design plan with detailed explanation that completely addresses the criteria, constraints AND intent of the problem. • Uses relevant and adequate amounts of evidence (data or scientific knowledge) to explain how the design addresses the problem, constraints ANS uses the evidence to explain an appropriate redesign of the original model or prototype.	• Proposes a design plan and evaluates the suitability of the design to address the criteria, constraints AND intent of the problem. • Uses detailed and multiple sources of evidence (data or scientific knowledge) to evaluate how well the design addresses the problem as well as constraints AND provides a detailed rationale with supporting data for appropriate redesign of the original model or prototype.

SEP7: Engaging in Argument from Evidence			
Argumentation is the process by which evidence-based conclusions and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims.			
Novice **1 – 2**	**Intermediate** **3**	**Intermediate** **4**	**Expert** **5 – 6**
• The student is able to present arguments on disciplinary content, which are unfocused or unsupported with evidence. • The student is able to communicate some procedures but lack details needed for others to replicate.	• The student is able to present arguments on disciplinary content, which are logical and focused, but lack evidence that supports the argument. • The student is able to provide step-by-step procedures that lack the detail needed for other to replicate.	• The student is able to present arguments on disciplinary content that are logical, focused and supported with sufficient and relevant evidence. • The student is able to provide step-by-step procedures that are precise and detailed enough so others can replicate them and (possibly) produce the same results.	• The student is able to present arguments on disciplinary content that are logical, focused and supported with sufficient and relevant data. Interpretation of the data makes insightful connections to other contents or disciplines, or draws relevant conclusions to real world applications or problems. • The student is able to provide step-by-step procedures that are precise and detailed enough so others can replicate them and (possibly) produce the same results.

SEP8: Obtaining, Evaluating, and Communicating Information			
Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity. Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to obtain information that is used to evaluate the merit and validity of claims, methods, and designs.			
Novice **1 – 2**	**Intermediate** **3**	**Intermediate** **4**	**Expert** **5 – 6**
• When conducting independent research, relies on one or two relevant sources without evaluating their credibility. • The student is able to communicate with some clarity but concepts may be inaccurate or inappropriate as related to the task, purpose or audience.	• When conducting independent research, selects a limited number of relevant scientific sources and evaluates their credibility minimally. • The student is able to communicate in a way that is clear and coherent, but the organization and style may not be appropriate to the task, purpose or audience.	• When conducting independent research, selects multiple relevant sources, and evaluates the evidence and credibility of each source. • The student communicates in a way that is clear and coherent, and in which the development, organization and style are appropriate to the task, purpose and audience.	• When conducting independent research, selects multiple relevant, high-quality scientific sources representing a variety of viewpoints, and thoroughly evaluates the evidence and credibility of each source. • The student communicates in a way that is clear and coherent, and in which the development, organization and style are appropriate to the task, purpose and audience.

General Grading Rubric

Expert	**6**	• Near perfect demonstration of understanding/skill; high confidence; mastery of learning standard. • Errors in concepts are identified and eliminated.	• "You could teach this!"
	5	• Strong demonstration of understanding/skill; high confidence. Slight error involved. • Minor concept errors made during assessments.	• "Almost perfect!"
Apprentice	**4**	• Good demonstration of understanding/basic skills; confidence evident. A few errors. • A few errors and learning gaps of course material.	• "Good overall understanding of the course material."
	3	• Satisfactory demonstration of understanding/basic skills; key concepts are lacking. Errors are common. • The grasp of course concepts is minimal, but enough of the concepts are understood to pass.	• "You are missing many of the key concepts, but have achieved the bare minimum to pass."
Novice	**2**	• Minimal understanding of key concepts and rudimentary demonstration of basic skills. • Not enough concepts understood to pass.	• "You are starting to understand."
	1	• Inadequate understanding key concepts and little to no demonstration of basic skills. • Errors throughout and/or questions unanswered.	• "Credit or pass not possible at this time."

Percent Mark from Grade

Learning Category	**Classification Level**	**Only shortly before report cards will a percentage mark be discussed and determined**		
Expert	6	95 – 100		
	5	86	90	94
Apprentice	4	73	80	85
	3	60	66	72
Novice	2	50	56	59
	1	0	25	49