**Constructing Explanations and Designing Solutions (9-12)**

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| 1. **Constructing Explanations** | **0** | **1** | **2** |
| 1. **Articulating the explanations of phenomena**   a. Students clearly articulate the explanation of a phenomenon, including a grade appropriate level of the mechanism involved. |  |  |  |
| **2. Evidence**  a. Students cite evidence to support the explanation. The evidence can come from student-generated data or from other sources, such as observations, reading material, or archived data. The evidence needs to be both appropriate and sufficient to support the explanation |  |  |  |
| **3**. **Reasoning**  a. Students describe the reasoning that connects the evidence to phenomena, tying in scientific background knowledge, scientific theories, or models. |  |  |  |
| **4**. **Revising the explanation (as necessary)**  a. Given new evidence or context, students construct a revised or expanded explanation. |  |  |  |

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| 1. **Designing Solutions** | **0** | **1** | **2** |
| 1. **Using scientific knowledge to generate the design solution**   - - - - - - - - - - - - - - - - - -  a. Students restate the original complex problem into a set of two or more subproblems |  |  |  |
| b. For at least one of the sub-problems, students propose two or more solutions |  |  |  |
| c. Students describe the scientific rationale for each solution, including choice of materials and structure of the device where appropriate. |  |  |  |
| d. If the students propose solutions for more than one sub-problem, they describe how the solutions to the sub-problems are interconnected to solve all or part of the larger problem. |  |  |  |
| 1. **Describing criteria and constraints, including quantification when appropriate**   - - - - - - - - - - - - - - - - - - - - -  a. Students describe criteria and constraints for the selected sub-problem(s). |  |  |  |
| b. Students describe the rationale for which criteria should be given highest priority if tradeoffs must be made. |  |  |  |
| 1. **Evaluating potential solutions**   a. Students evaluate the solution(s) to a complex real-world problem systematically, including:  i. Analysis (quantitative where appropriate) of the strengths and weaknesses of the solution with respect to each criterion and constraint, as well as social and cultural acceptability, and environmental impacts; |  |  |  |
| ii. Consideration of possible barriers to implementing each solution, such as cultural, economic, or other sources of resistance to potential solutions; and |  |  |  |
| iii. An evidence-based decision of which solution is optimum, based on prioritized criteria, analysis of the strengths and weaknesses (costs and benefits) of each solution, and barriers to be overcome. |  |  |  |
| **4. Refining and/or optimizing the design solution**  a. Students refine or optimize the solution(s) based on the results from the evaluation. |  |  |  |
|  | **0** | **1** | **2** |