[redacted]

Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

3. The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

Students:

- ¥ organize observations and measurements of objects and events through classification and the preparation of simple charts and tables.
- ¥› interpret organized observations and measurements, recognizing simple patterns, sequences, and relationships.
- ¥› share their findings with others and actively seek their interpretations and ideas.
- ¥› adjust their explanations and understandings of objects and events based on their findings and new ideas.

This is evident, for example, when students:

- ▲ prepare tables or other representations of their observations and look for evidence which supports or refutes their explanation of *why objects sink or float when placed in a container of water.** After sharing and discussing their results with other groups, they prepare a brief research report that includes methods, findings, and conclusions. The report is rated on its clarity, care in carrying out the plan, and presentation of evidence supporting the conclusions.

Engineering Design

1. Engineering design is an iterative process involving modeling and optimization finding the best solution within given constraints which is used to develop technological solutions to problems within given constraints.

Students engage in the following steps in a design process:

- ¥› describe objects, imaginary or real, that might be modeled or made differently and suggest ways in which the objects can be changed, fixed, or improved.
- ¥› investigate prior solutions and ideas from books, magazines, family, friends, neighbors, and community members.
- ¥› generate ideas for possible solutions, individually and through group activity; apply age-appropriate mathematics and science skills; evaluate the ideas and determine the best solution; and explain reasons for the choices.
- ¥› plan and build, under supervision, a model of the solution using familiar materials, processes, and hand tools.
- ¥› discuss how best to test the solution; perform the test under teacher supervision; record and portray results through numerical and graphic means; discuss orally why things worked or didn't work; and summarize results in writing, suggesting ways to make the solution better.

This is evident, for example, when students:

- ▲ read a story called Humpty's Big Day wherein the readers visit the place where Humpty Dumpty had his accident, and are asked to design and model a way to get to the top of the wall and down again safely.
- ▲ generate, draw, and model ideas for a space station that includes a pleasant living and working environment.
- ▲ design and model footwear that they could use to walk on a cold, sandy surface.

* A variety of content-specific items can be substituted for the italicized text

Standard 1—Analysis, Inquiry, and Design

Intermediate

Mathematical Analysis

Scientific Inquiry

1. Abstraction and symbolic representation are used to communicate mathematically.

Students:

- ¥› extend mathematical notation and symbolism to include variables and algebraic expressions in order to describe and compare quantities and express mathematical relationships.

2. Deductive and inductive reasoning are used to reach mathematical conclusions.

Students:

- ¥› use inductive reasoning to construct, evaluate, and

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3. The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

Students:
- ¥› design charts, tables, graphs and other representations of observations in conventional and creative ways to help them address their research question or hypothesis.
- ¥› interpret the organized data to answer the research question or hypothesis and to gain insight into the problem.
- ¥› modify their personal understanding of phenomena based on evaluation of their hypothesis.

This is evident, for example, when students:
- ▲ carry out their plan making appropriate observations and measurements. They analyze the data, reach conclusions regarding their explanation of the disparity between the amount of solid waste which is recycled and which could be recycled.*, and prepare a tentative report which is critiqued by other groups, refined, and submitted for assessment. The report is rated on clarity, quality of presentation of data and analyses, and soundness of conclusions.

Engineering Design

1. Engineering design is an iterative process involving modeling and optimization finding the best solution within given constraints which is used to develop technological solutions to problems within given constraints.

Students engage in the following steps in a design process:
- ¥› identify needs and opportunities for technical solutions from an investigation of situations of general or social interest.
- ¥› locate and utilize a range of printed, electronic, and human information resources to obtain ideas.
- ¥› consider constraints and generate several ideas for alternative solutions, using group and individual ideation techniques (group discussion, brainstorming, forced connections, role play); defer judgment until a number of ideas have been generated; evaluate (critique) ideas; and explain why the chosen solution is optimal.
- ¥› develop plans, including drawings with measurements and details of construction, and construct a model of the solution, exhibiting a degree of craftsmanship.
- ¥› in a group setting, test their solution against design specifications, present and evaluate results, describe how the solution might have been modified for different or better results, and discuss tradeoffs that might have to be made.

This is evident, for example, when students:
- ▲ reflect on the need for alternative growing systems in desert environments and design and model a hydroponic greenhouse for growing vegetables without soil.
- ▲ brainstorm and evaluate alternative ideas for an adaptive device that will make life easier for a person with a disability, such as a device to pick up objects from the floor.
- ▲ design a model vehicle (with a safety belt restraint system and crush zones to absorb impact) to carry a raw egg as a passenger down a ramp and into a barrier without damage to the egg.
- ▲ assess the performance of a solution against various design criteria, enter the scores on a spreadsheet, and see how varying the solution might have affected total score.

* A variety of content-specific items can be substituted for the italicized text

Standard 1—Analysis, Inquiry, and Design

Commencement

Mathematical Analysis

1. Abstraction and symbolic representation are used to communicate mathematically.

Students:

¥› use algebraic and geometric representations to describe and compare data.

2. Deductive and inductive reasoning are used to reach mathematical conclusions.

Students:

¥› use deductive reasoning to construct and evaluate conjectures and arguments, recognizing that patterns and relationships in mathematics assist them in arriving at these conjectures and arguments.

3. Critical thinking skills are used in the solution of mathematical problems.

Students:

¥› apply algebraic and geometric concepts and skills to the solution of problems.

Scientific Inquiry

1. The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

Students:

¥› elaborate on basic scientific and personal explanations of natural phenomena, and develop extended visual models and mathematical formulations to represent their thinking.

¥› hone ideas through reasoning, library research, and discussion with others, including experts.

¥› work toward reconciling competing explanations; clarifying points of agreement and disagreement.

¥›

Key ideas are identified by numbers (1).
Performance indicators are identified by bullets (•).
Sample tasks are identified by triangles (▲).

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