Paper Task: Cool Clothes

Background

In this task, students identify a user and constraints before designing a model of a cooling vest. Students also analyze a data table to select and describe the optimal starting substances for the cold packs and identify a tradeoff. Paper tasks allow more flexibility for teachers to assess in other ways, while still minimizing the language load for students.

In preparation for this task, students should have an understanding of the *Next Generation Science Standards* (disciplinary core ideas, science and engineering practices, and crosscutting concepts) as outlined in the tables below.

Disciplinary Core Ideas (DCI)
PS1.B: Chemical Reactions • Some chemical reactions release energy, others store energy. **ETS1.A: Defining and Delimiting Engineering Problems** • Specification of constraints includes consideration of scientific principles and other relevant knowledge.

Science and Engineering Practices (SEP)
Constructing Explanations & Designing Solutions • Construct an explanation that includes qualitative or quantitative relationships between variables. • Undertake a design project to implement a solution that meets specific design criteria and constraints. **Modeling** • Develop a model to show the relationships among variables, including those that are not observable but predict observable phenomena. **Analyzing & Interpreting Data** • Analyze data to define an object that best meets criteria for success.

Crosscutting Concepts (CCC)
Matter & Energy • The transfer of energy can be tracked as energy flows through a natural or designed system.

Learning Progressions

The tasks were designed based on current understanding of learning progression research in science education (National Research Council, 2012). Learning progressions describe how students develop successively more sophisticated ways of reasoning about science content as they obtain more experience with phenomena/representations, and improve their cognitive abilities (Smith, Wiser, Anderson, & Krajcik, 2006).

The Framework for K-12 Science Education (National Research Council, 2012) addresses the progression of Disciplinary Core Ideas (DCIs) throughout the sciences. The focus for Cool Clothes is chemical reactions and thermal energy transfer. This task incorporates concepts from physical science and engineering. The following are the "Grade Level End Points" identified within the *Framework* (2012). These endpoints are included here because they summarize the learning progressions intended by the standards prior to middle school and by the end of middle school.

PS1.B: Chemical Reactions

By the end of grade 5. When two or more different substances are mixed, a new substance with different properties may be formed; such occurrences depend on the substances and the temperature. No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.)

By the end of grade 8. Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. The total number of each type of atom is conserved, and thus the mass does not change. Some chemical reactions release energy, others store energy.

(National Research Council, 2012, pages 110-111)

ETS1.A: Defining and Delimiting an Engineering Problem

By the end of grade 5. Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.

By the end of grade 8. The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions (e.g., familiarity with the local climate may rule out certain plants for the school garden).

(National Research Council, 2012, pages 206)