Task III: Design and Test Prototype

Oregon Science Standards: (NGSS):5-PS2 Motion and Stability, 3-5-ETS1 Engineering Design

Vocabulary: gravity, air resistance, force, variable, control, friction, speed, velocity, acceleration, potential energy, kinetic energy

Materials: Lab sheets, (available to all groups) straws, masking tape, cardboard, cardstock, string, popsicle sticks, rubber bands, packing peanuts, toilet paper tubes, cotton balls, foam trays, egg cartons (1 well), paper cups, plastic grocery bag, Styrofoam cups, paper plates, Ziploc bags (gallon and sandwich size), eggs, stopwatch, tarp

Background: This lab is designed for students to work in groups of 3 or 4, and a duration of three to four 90 minute sessions over a week's time.
Students will be working to design and protect a real egg, and the drop height is increased from 6ft to 32 ft. They will be designing for the strongest and most economical design.
Supplies and prices are in the chart below.

• Straws $.10 each • Tape (masking) @ $1.00 a foot • Cardboard (square foot) @ .75 • String @ $.35 a foot, $.18 a half-foot • Popsicle sticks @ $.55 each • Rubber Bands @ $.60 each • Packing Peanuts @ $.50 each • Toilet Paper Tubes @ $.50 each	• Cotton Balls @ $.50 each • Foam tray @ $.75 each • Egg Carton (1 well) @ $.85 • Paper cups $.50 • Styrofoam cup $3.00 • Paper plates $1.50 • Ziploc bags (L = $1.00 S = $.50) • Cardstock (per sq. ft.) $.50 • Plastic grocery bag $1.00

Before groups begin their designing and testing, review the expectations, materials, material usage, and the lab sheet.

Growth Mindset Considerations:

- Direct praise toward the value of planning and trying new approaches rather than praising just intelligence and effort. A focus only on intelligence and effort can be discouraging to students if their efforts seem to be falling short or they don't perceive their intelligence in this content area.

- Emphasize with students that they may encounter challenges during this task. These are not roadblocks but opportunities for growth. By making an effort to push through, students can increase their science thinking/learning and people skills

- Encourage students to expand their answers and process the content of their answers on a deeper level. This will help them know what they know and what they need to work on. This can be done by sharing ideas in small or large groups. Encourage students to ask questions of those presenting to emphasize critical thinking.

- Incorporate the word “yet” to change negative sentences into positive ones. “We can't come up with a good design.” “We can’t come up with a good design, yet.” This encourages persistence and trying new approaches to learning.

- Encourage students to change their language by incorporating “yet” or turning negative statements like “We made a mistake.” to “This is another chance for us to learn.”

Student Preface: Welcome to stage three! As an engineering design team you will now consider the best of the best ideas you created over the past two days, and plan an initial design that incorporates hard casing, soft padding and air resistance into one prototype. Remember to consider all of your science learning experience over the past few days and how it will impact your designs. Today your supplies are expanded, however, they now come with a price tag. You will not be given a budget, but you must keep track of the price of your prototype. RADR executives will want a prototype that is not only strong, but economical to produce. Today your prototype will protect a real egg (that is easily accessible in your design), and be dropped from a height of 32 feet. After your initial design, construction, and drop test, you will be given the opportunity to reflect on the results, redesign and retest.

Before you begin, take a moment to think individually about your science knowledge and design ideas. How would you best combine them? Take some notes about your thinking. Have a quick sharing session about your ideas and decide which ones you will test in your trials. Remember to consider the pricing element today. Don’t be afraid to think creatively and “outside the box”.

Design Procedure:

Each group member will take time to consider their previous science knowledge and design ideas. They will also now consider the price of materials in their design. Each group member will work on a design plan to include on their lab sheet and share with their group.

Once everyone has shared they will cooperatively decide what elements to include in their prototype and draw a labeled diagram on their lab sheet for Prototype #1.

As they design and build, groups must list materials and quantities used and calculate the total cost. Once the prototype is finished, groups must let their teacher know. She will check to make sure the lab sheet is complete and there is easy access for the egg to be inserted.

Groups will then take a picture of their prototype, weight it, determine its dimensions in centimeters and its volume. All this information should be recorded on their lab sheets.

Test Procedure:
When groups are ready to test, the egg must be inserted and given to the adult who will be doing the dropping. Students will also need to get a stopwatch and time how long it takes their prototype to hit the ground they may take video if they wish. After the adult drops the prototype, groups will check the state of their egg and record the results in their lab.

Redesign Procedure:
Students will consider their results and their previous science knowledge to create an improved redesign of their first prototype. Students could make improvements to change the state of the egg, increase or decrease air resistance, or make adjustments to casing or padding design. Changes will be documents on lab sheets.

Retest Procedure:
When groups are ready to test, the egg must be inserted and given to the adult who will be doing the dropping. Students will also need to get a stopwatch and time how long it takes their prototype to hit the ground. They may take video if they wish. After the adult drops the prototype, groups will check the state of their egg and record the results in their lab.

Reflect/Present Procedure:
Using observations from today's trial testing, groups will reflect, discuss, and document their results. Which combinations of casing and padding and methods of air resistance did students find to be the strongest and most economical? Students will take this information and make a slideshow to present their findings. The slide show must include pictures of their prototypes, materials used, the cost, and the results of the drop.

Have groups present slideshows to the class. Encourage students to ask questions of other presenter and groups to clarify thinking and ideas.

In an individual reflection based on the information presented, which design(s) should be presented to RADR executives? What are the designs pros and cons?

Have students reflect on their teamwork over the week. Was it easy or hard? What worked well and what didn't? Are there any improvements that could be made or worked on for the future?

Evaluation: Students will be evaluated on the content and completion of the answers on their lab sheet as well as including labeled diagrams. They will be evaluated on the completion of their slide show, its contents and their presentation. Students will be evaluated on the completion and contents of their personal reflection.