Candy Container

2nd – 8th
NGSS Aligned

VALENTINE'S STEM CHALLENGE

DIGITAL/PAPERLESS VERSION

FOR USE WITH GOOGLE SLIDES

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Thanks & happy teaching!

~ Kerry

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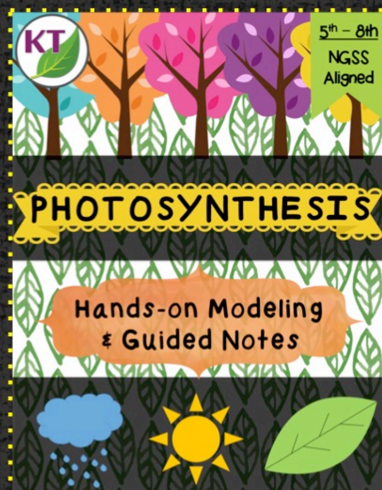
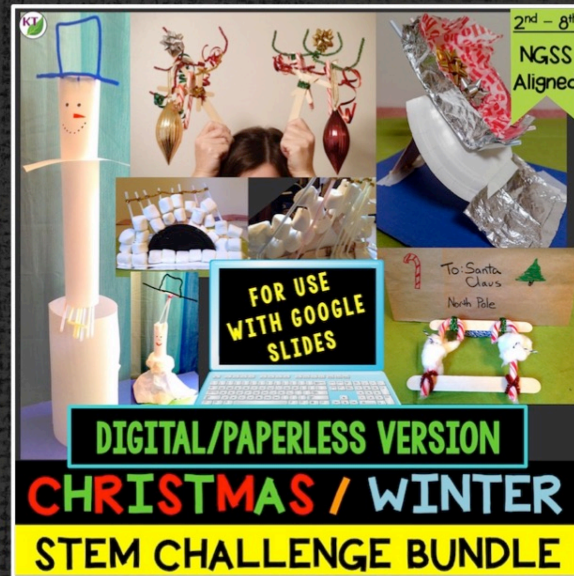
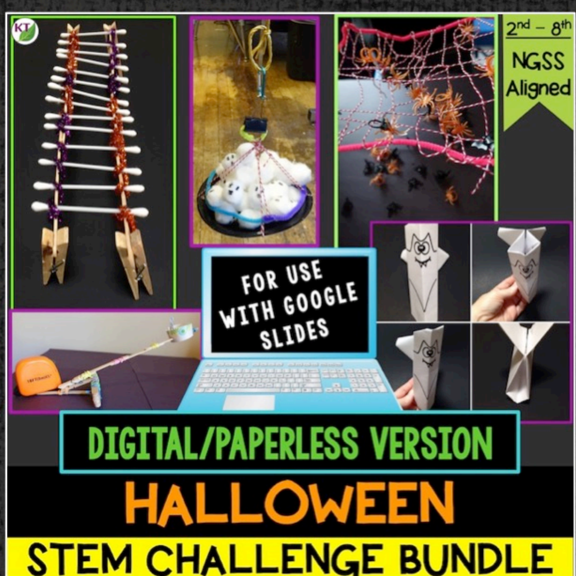
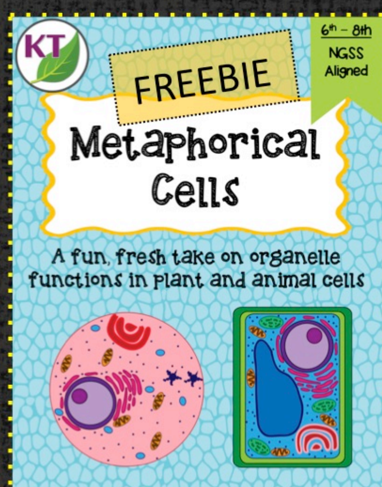
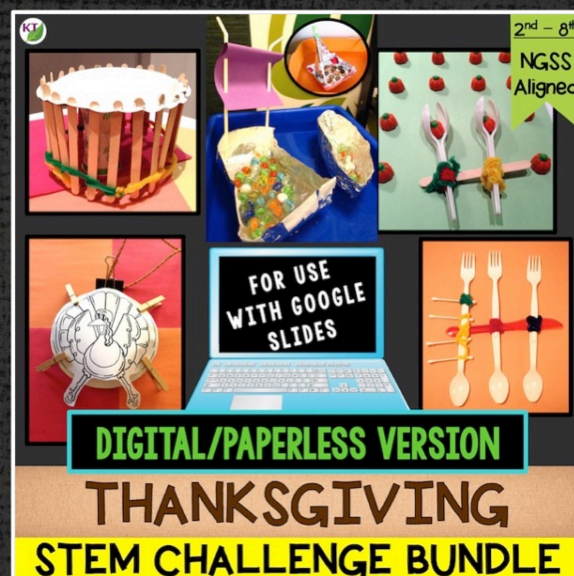
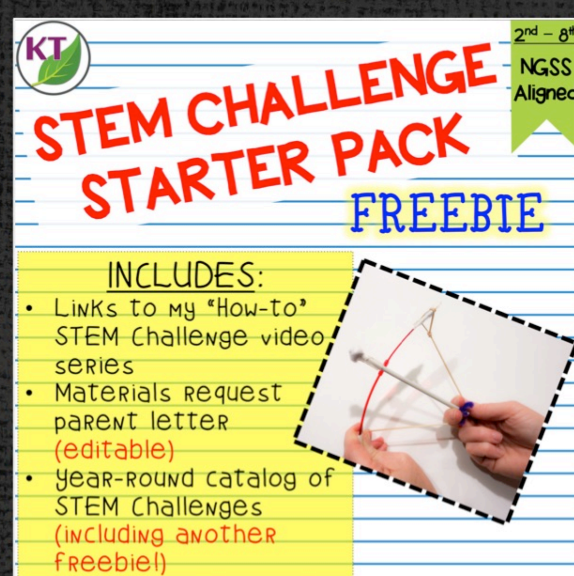












Valentine's Day STEM Challenge:

CANDY/ CONFECTION CONTAINER

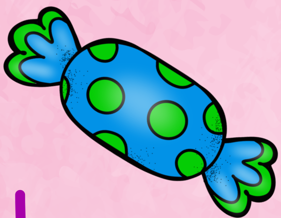


TABLE OF CONTENTS

Click on any entry below to navigate through the document.

CLICK HERE TO GO STRAIGHT TO THE MASTER FILE IN GOOGLE SLIDES.

GETTING STARTED

1. Your students will need their own Google accounts to access the file in Google slides. If you need help setting up Google Classroom, search for how-to videos on YouTube. I found this one helpful, but there are plenty to choose from!

2. Review the Teacher Tips for this challenge in the following pages.

3. Create a copy of the master Google Slides file. Rename this file "Teacher" or "Master" copy. There is a video on slide 1 that provides a quick explanation of the file contents/layout.

4. Create a second copy of the file for your students. This way, you always have a master copy with all the slides available. In the student file, delete any pages you don't wish to have students complete, or consider breaking the large file into smaller chunks (Day 1, Day 2, etc.) prior to sharing the file with your class.

Candy / Confection Container Materials

Select from the list. Materials can be purchased at you local dollar store or Target/ Wal-Mart, etc. Make sure students have an equal amount of each material provided.

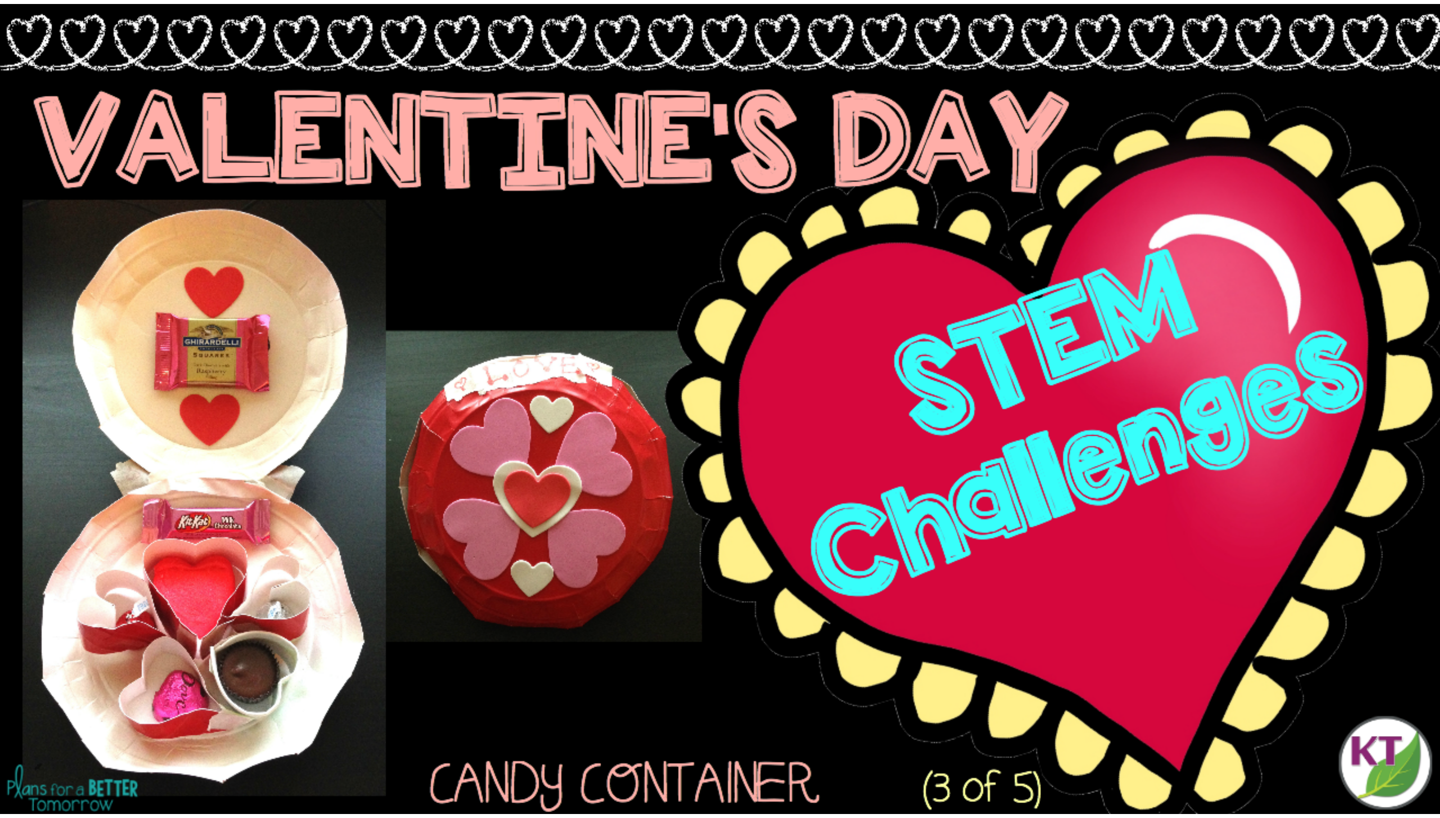
- **For each student or group:**
  - Assortment of candy (4 – 8 pieces). A variety of shapes is desired.
    - “Confection Container” Alternative: one or more cupcakes
  - Cardboard/cardstock (paper plates, cereal boxes, Valentine’s cards boxes, etc.)
  - Craft sticks (5-10)
  - Pipe cleaners (5 – 10)
  - Tape (24 in.)
  - Scissors
  - Ruler
  - Copies of data recording & analyzing slides
  - Optional:
    - Valentine’s decorations (lace, ribbons, hearts, etc.) or construction paper, markers, and glue
    - Tissue paper
    - Foil
    - Toothpicks
    - String
    - Small paper cups
    - Straws (5 – 10)

Choose candy or cupcakes as primary materials.

Video Walk-Through

The image below is linked to the video walk-through of this challenge.

For more Valentine's STEM Challenge Videos, check out this playlist.



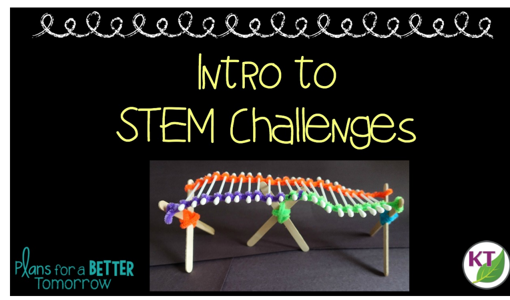
Note to Teachers

The beauty of STEM Challenges is that they are open-ended and require critical thinking and problem-solving. This is why we don't give students directions to build a specific design. In keeping with the engineering design process, a criteria & constraints list is provided to give students a framework of the design problem and goal. How they choose to address the problem and goal is entirely up to them.

You can tailor the challenge to your students' needs using the editable list provided, but don't make it too easy! Be bold and embrace the *challenge* – it's in the title after all! Understand that the potential to fail is an inherent risk, and in fact, when you're prepared for that possibility, a "failure" can turn into a far richer lesson than a success. Check out the first video linked below for more on what you can do to prepare for – and even look forward to – a potential "fail"!

Videos & PD

Video is such an effective way to share tips and examples for running fantastic STEM Challenges! I've linked a few below to help get you started and cover some troubleshooting topics as well.



You can also find my full video library & newest PD on:

YouTube

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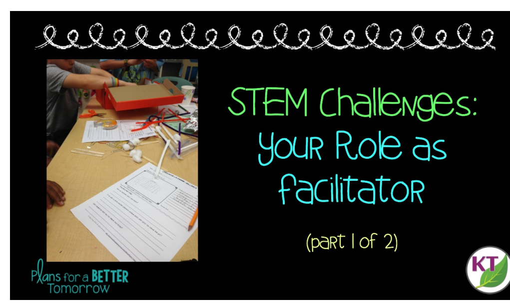
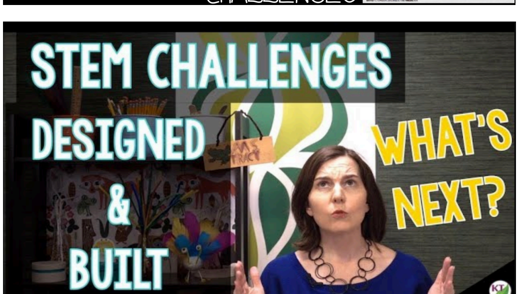
If you have any questions, please feel free to reach out via email or social media!





- **Premise**
  - Working against a criteria/constraints list Individually or in partners/groups, students will design and build the smallest container possible to house a candy assortment.
    - "Confection Container" alternative: students will design and build the smallest container possible to house one or more cupcakes (keeping frosting on the cupcakes, not the box!)
    - Because this can be treated as two separate challenges, two editable criteria/constraints lists have been provided: one for candy and another for confection (cupcake).
  - Plan to give students approximately 40 min. to design, 10-15 min. to measure and share results, and 10-15 to complete data analysis slides. Additional time will be needed if you are assigning extension activities.

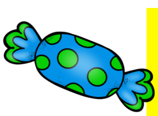
- **Set Up**
  - Watch the challenge walk-through video.
  - If you are new to STEM challenges, watch one or more "how-to" videos.
  - Purchase an assortment of candy (or cupcakes, if choosing the "Confection Container" challenge).
  - Decide if you'll run this as a STEAM challenge (including art); if so, provide materials (and potentially additional criteria) to increase the aesthetic appeal of containers. If not, remove the existing criterion re: eye-catching/appealing design from the criteria/constraints list.

- **Criteria/Constraints**
  - Decide whether you will make adjustments to the Criteria & Constraints List ahead of time. (The Criteria & Constraints List slide is editable.)
  - Increase or decrease the time as needed.
  - Ideas to increase the difficulty of the challenge:
    - Give students fewer or no rigid materials (i.e. little or no cardboard, craft sticks, etc.).
    - Add a secondary challenge to build a device to display multiple containers in-store.
    - Add an in-store shelf-size constraint (e.g. at least 10 units must fit on a 12 x 6 x 6 in. shelf in Target).
    - Add a criterion for lightest weight possible.
    - Allow students to select down from provided candy assortment (e.g. have them strategically select 6 of 8 given pieces).
    - Add a criterion to resist collapse under a given weight (e.g. 2 lb. weight or single water bottle).
    - If incorporating art, add criteria to work in the style of a particular artist and/or use cool, warm, complementary, or analogous colors in their designs.

- **Measuring Results**
  - Students should verify they have met all listed criteria/constraints.
  - On the Design Analysis slides, there is space for students to record results. For any criteria you do not wish them to record, have them type "NA" in the space.
  - Length, width, and height measurements should be taken at their greatest point, if an irregular shape. (Measuring weight is optional.)
  - To test the stackable criterion, choose one of the following:
    - Stack paperback book(s) on top of design and check evenness
    - Stack containers of other groups on top and check evenness
    - Bring in a level (check your local dollar store or hardware store) and place on top of containers to check evenness.
  - For the "eye-catching" criterion, students can give themselves a score out of 10 possible points, or teams can score each other.

Candy / Confection Container Teacher Tips (pg. 3 of 3)

- **Post-Design Options**
  - Design analysis (slides included)
  - Discussion questions (slides included)
  - Re-design and re-test (consider incorporating new, student-suggested materials).
  - Extension activities
    - Create shipping box and/or delivery truck dimensions. Have groups calculate and diagram how many of their containers fit inside and how much unused/ wasted space exists. Groups then discuss and propose a plan to optimize their packaging. Editable slides & various options included (see description).
      - Consider listing several possible size options for shipping boxes and delivery trucks and have students select/prove the optimal combination of box and delivery truck for their container design. To increase difficulty further, give some dimensions in inches and others in feet (or some in customary and others in metric) so students practice conversions.
    - Post container dimensions for every group. Have students plot out and diagram how to display 10 – 20 of each group's containers on in-store shelves. (You can set shelf dimensions as standard, or include a top shelf with extra headroom for larger containers.)
    - Create print or social media ads, viral videos, or TV commercials to advertise containers.
    - Give students retail math questions (e.g. Assuming your container costs $1.50 to produce & ship and you want to make xx% profit, how much do you need to charge?)
      - Sites for retail math formulas: http://www.calculatorsoup.com/calculators/financial/margin-calculator.php
      - http://retail.about.com/od/retailingmath/a/retail_formulas.htm
    - Students create a process flow map for how to make their container designs. They trade process maps and try to build the other's design (process flow map slide included).
    - Students create and solve math problems related to designs (slide included).



Note: One slide per website is included in the student slides with its link, so you can easily assign to students.

Universal STEM Challenge Notes & How to Use the Design Analysis Slides

STEM Challenge Cycle (overview video of the STEM Challenge steps)

Planning

- Try giving students experience with different planning styles on different challenges, so they can begin to understand their own preferences. Several approaches are listed below:
  - Students begin to manipulate materials immediately
  - Students sketch ideas prior to building
  - Students discuss ideas with teammates prior to building
  - Have students jot notes for their plan prior to building
  - Students have 3 – 5 minutes of silence to think about what they will do prior to building (follow with another approach, or go straight into building)
  - Walk & talk: Introduce the challenge, then have students go on a short walk to discuss ideas with teammates prior to building
  - Free choice or mix/combine approaches

Post-Design – Design Analysis Slides

- Multiple iterations are always recommended to allow students an opportunity to apply learning, try new ideas, and to be in keeping with the engineering process. While you might not be able to do so with every challenge, try to do it whenever you can. Never conducting a second or third iteration is akin to never asking students to tell you how they *could* improve their writing, but never actually having them revise it; the execution of ideas is crucial in developing skills!
  - For each new iteration, make a new copy of the design analysis slides.
  - The following analysis question can be used in different ways: "Which was your more/most effective design? What do you think it was about the design that made it superior to the other(s)?":
    - **Option 1:** Have students consider the evolution of their design within the current iteration of the challenge. Frequently, students change aspects of the design right up until time is called. Their final version is not necessarily the best version. If they insist they stuck with one idea throughout and have nothing to compare, select option 2 or 3 below.
    - **Option 2:** Students can select what they think was the most effective design in the class, not necessarily their own.
    - **Option 3:** If you will conduct multiple iterations, students can wait to answer this question until after the final iteration, and answer it only once on the final set of handouts (or use options 1 or 2 to answer the question prior to the last handout set).

Grades
2 - 8

Shipping Extensions

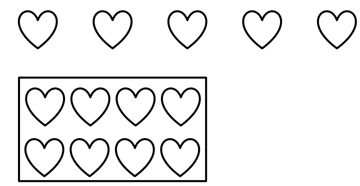
(Optional)

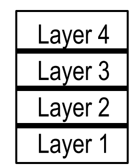
Teacher Tips for Shipping Exercises (pg. 1 of 2)

Option 1

For young students, the slides for the shipping exercises might be too advanced, but you can still do a hands-on variation on the topic. Show students a large cardboard box or storage container. Ask groups to estimate how many of their candy/confection containers could fit inside. Then provide newspaper or butcher paper for students to:

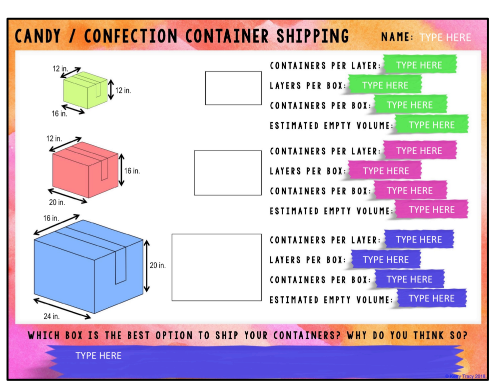
1. Trace their containers to create "footprints" to manipulate.
2. Measure and cut out the bottom face of the box.
3. Arrange the "footprints" on the face cut-out.
4. Now that a layer is established, students must determine how many layers they can fit in the box. Tell students it's like drawers in a dresser. Students measure the height of their container and compare to the height of the box. If you like, you can have students measure and cut a face for the side/height of the box and draw in lines for each layer based on the height of their designs.
5. Find the total number of candy/confection containers that fit inside the shipping box and show your work. Explain if there is any wasted space and how you could change the design or use packing materials to address it.
6. Consider setting up centers with a different size box at each. Students travel from center to center with their candy container and footprint cut-outs to repeat the exercise above, and find the best shipping container for their designs.





Option 2

Use the shipping slide shown below in conjunction with, or instead of, Option 1. The slide is editable, so you can change the dimension measurements or leave them blank and have students fill them in with your in-class examples.

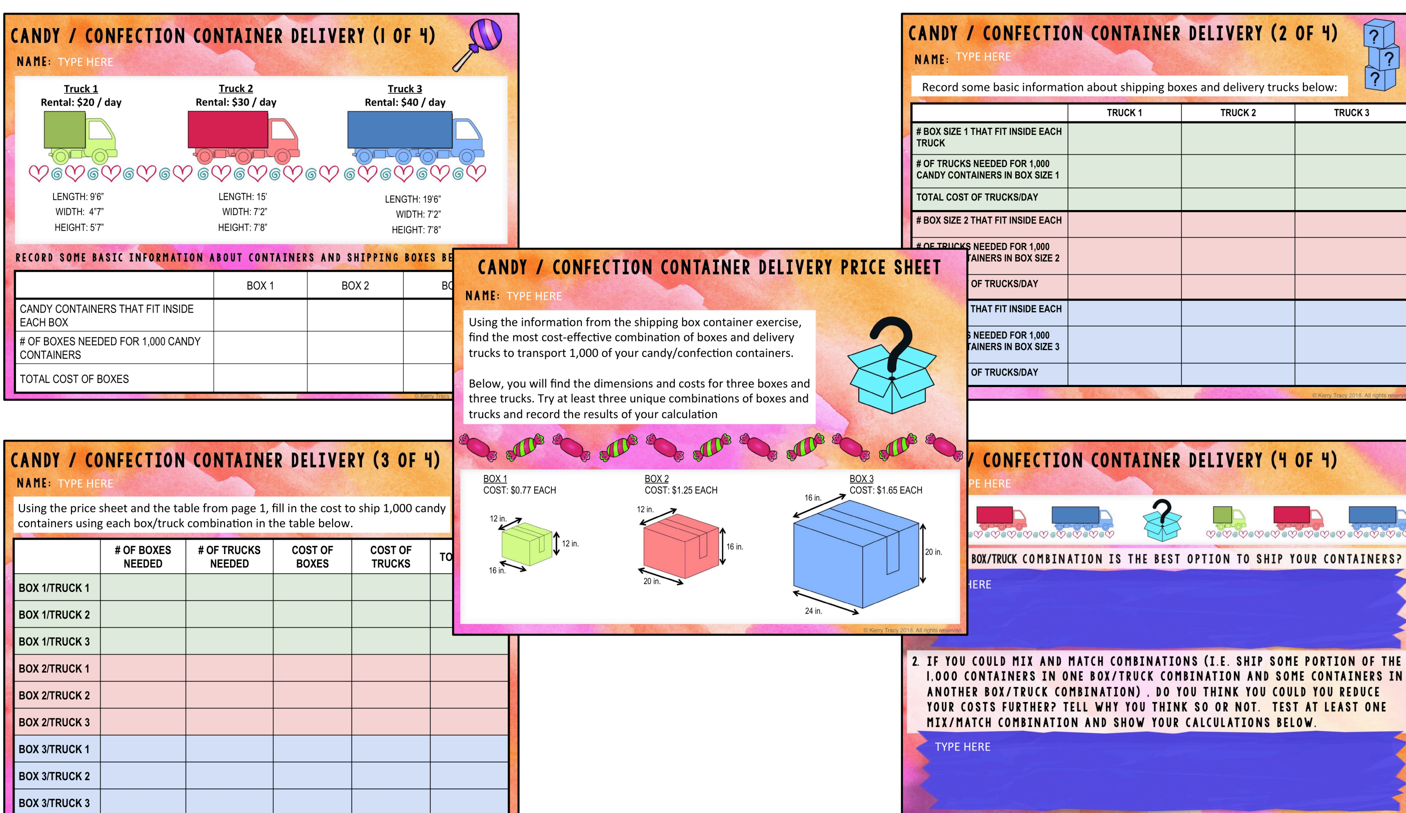


Teacher Tips for Shipping Exercises (pg. 2 of 2)

<u>Option 3</u>
Extend further by having students find the best combination of shipping box and delivery truck to ship 1,000 containers. Assume a 1-day trip for each truck rental to start. Have students use the price sheet and table slides to calculate box/truck combinations and present their findings to the class to validate their calculations make sense. These slides are editable, so you can change prices/dimensions as desired.

If it's age-appropriate, give students only the price sheet (without the table slides to organize their thoughts). Ask student groups to come up with their own approach/organization to determine which shipping box/truck combination is the most cost-effective. Give them ~20 minutes to discuss and begin working on their method; then stop and have each group explain how they plan to go about figuring out the problem. This allows groups without a plan to borrow one from another group, groups with a plan to clarify their thoughts and ask questions, and the teacher a chance to probe students' thinking and give advice.

If you want to extend further, make the transportation a multi-day trip with labor and fuel costs as added factors.



Next Generation Science Standards (NGSS)

A Note RE: NGSS Science & Engineering Practices

This STEM Challenge has the potential to hit upon all NGSS ETS standards depending on the depth and number of iterations you choose to implement in your classroom. Take a moment to review the Performance Expectations as well as the Disciplinary Core Ideas (DCIs) included here prior to inform your decisions and approach.

K-2 NGSS
Science & Engineering Practices: Performance Expectations

K-2 Science & Engineering Practices

Students who demonstrate understanding can:

- **K-2-ETS1-1.Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.**

- **K-2-ETS1-2.Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.**

- **K-2-ETS1-3.Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.**

K-2 NGSS Disciplinary Core Ideas (DCIs)

- **ETS 1.A: Defining and Delimiting Engineering Problems**
  - A situation that people want to change can be approached as a problem to be solved through engineering. (K-2-ETS1-1).
  - Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1).
  - Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)
- **ETS 1.B: Developing Possible Solutions**
  - Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2).
- **ETS 1.C: Optimizing the Design Solution**
  - Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3).

3-5 NGSS
Science & Engineering Practices: Performance Expectations

3-5 Science & Engineering Practices

Students who demonstrate understanding can:

- **3-5-ETS1-1.Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.**

- **3-5-ETS1-2.Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.**

- **3-5-ETS1-3.Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.**

3-5 NGSS Disciplinary Core Ideas (DCIs)

- **ETS 1.A: Defining and Delimiting Engineering Problems**
  - 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). Difference 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. (3-5 ETS1-1).
- **ETS 1.B: Developing Possible Solutions**
  - Research on a problem should be carried out before before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2).
  - At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5 ETS1-2).
  - Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3).
- **ETS 1.C: Optimizing the Design Solution**
  - Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3).

Teacher-Author note: I philosophically disagree with DCI 3-5-ETS1-2. With an iterative design approach, one often produces more innovative designs by *not* researching first. Design first also motivates students to have a reason to research between iterations. It's nice to have the baseline of design results before and after research as well. This challenge reflects my approach.

Middle School NGSS Science & Engineering Practices: Performance Expectations

MS Science & Engineering Practices

Students who demonstrate understanding can:

- **MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**

- **MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**

- **MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**

- **MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**

Middle School NGSS Disciplinary Core Ideas (DCIs)

- **ETS 1.A: Defining and Delimiting Engineering Problems**
  - The more precisely a design task's criteria and constraints can be defined, the more likely is is that the designed solution will be successful. Specification of constraints includes consideration of specific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1).
- **ETS 1.B: Developing Possible Solutions**
  - A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4).
  - There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3).
  - Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3).
  - Models of all kinds are important for testing solutions. (MS-ETS1-4).
- **ETS 1.C: Optimizing the Design Solution**
  - Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process – that is, some of those characteristics may be incorporated in the new design (MS-ETS1-3).
  - The iterative process of testing the most promising solutions and modifying what is proposed on the basis of test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4).

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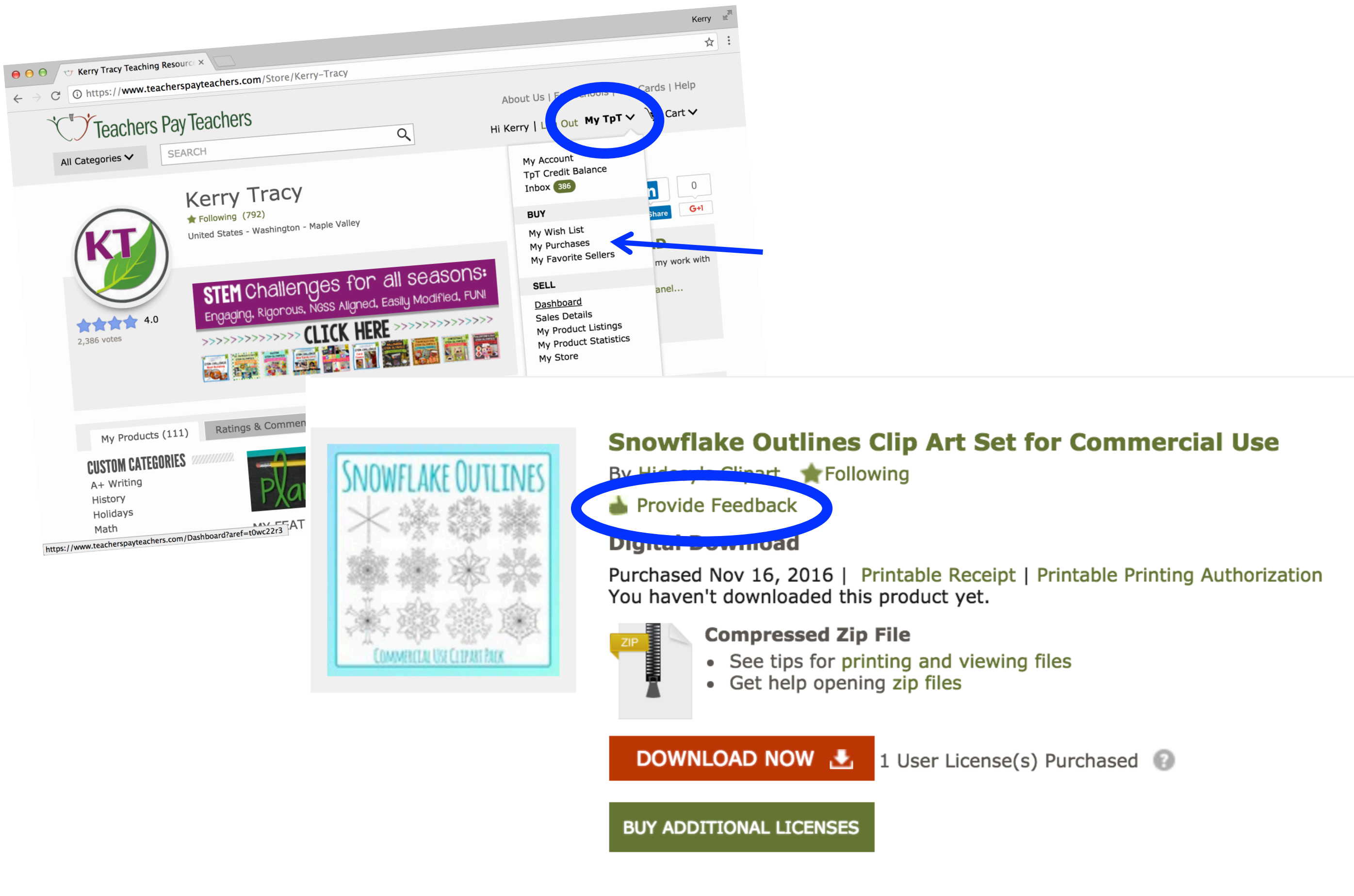

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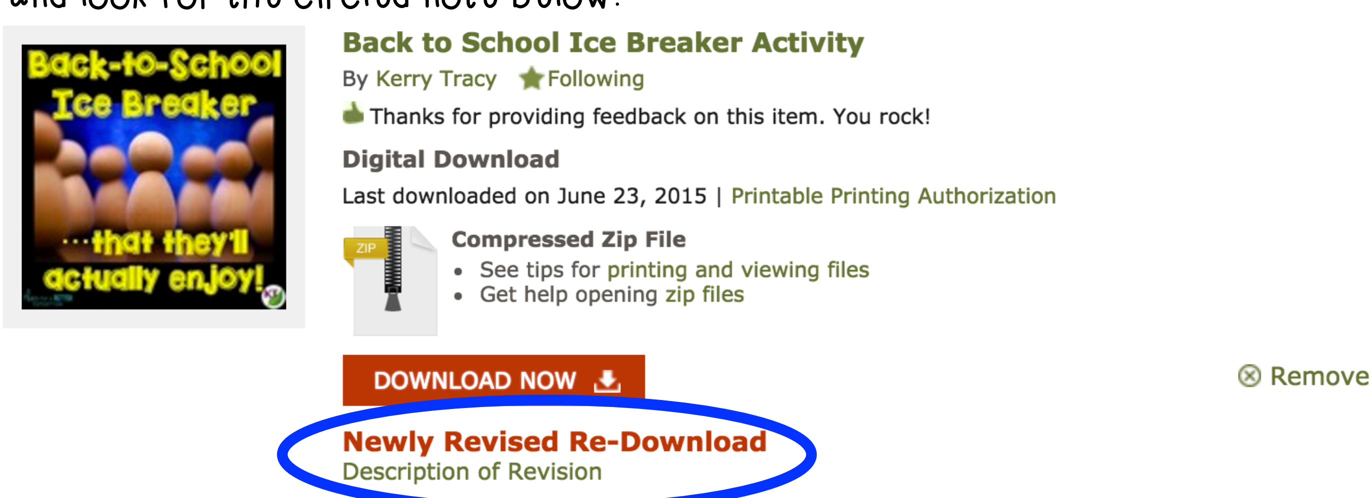

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