WINTER
STEM CHALLENGE

2nd – 8th
NGSS Aligned

FROSTED FOREST

DIGITAL/PAPERLESS VERSION

FOR USE WITH GOOGLE SLIDES

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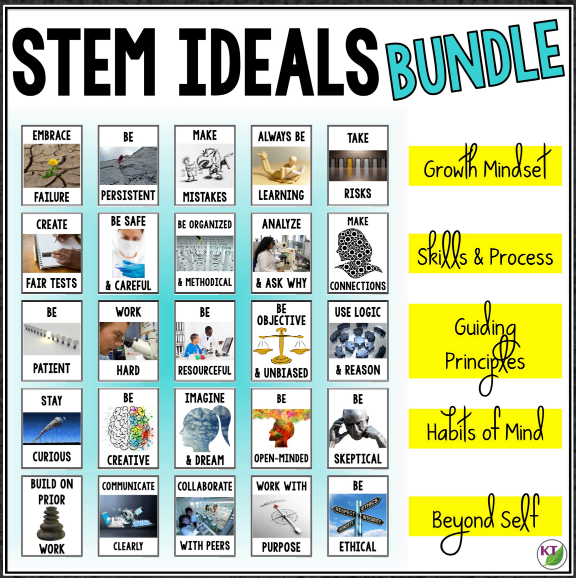
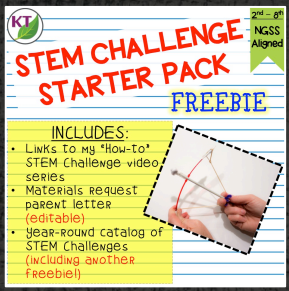
I look forward to your feedback. If you have questions or suggestions, please do not hesitate to contact me through any or all of the links below:

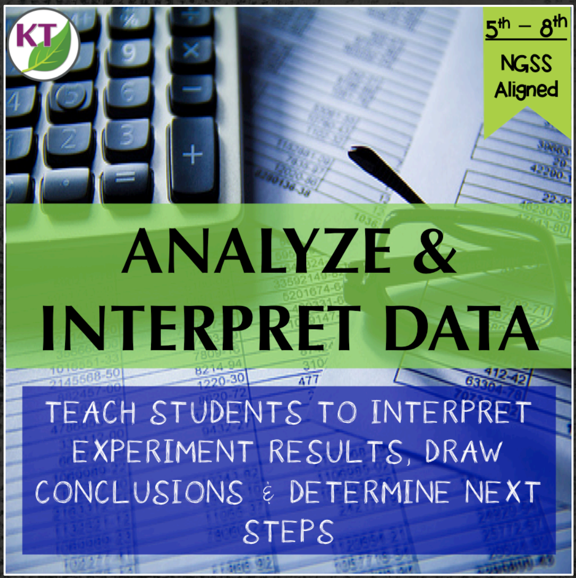
Thanks & happy teaching!

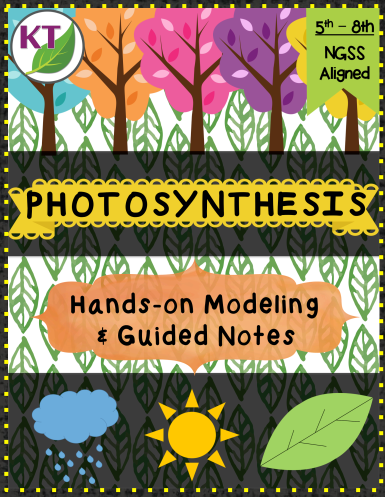
~ Kerry

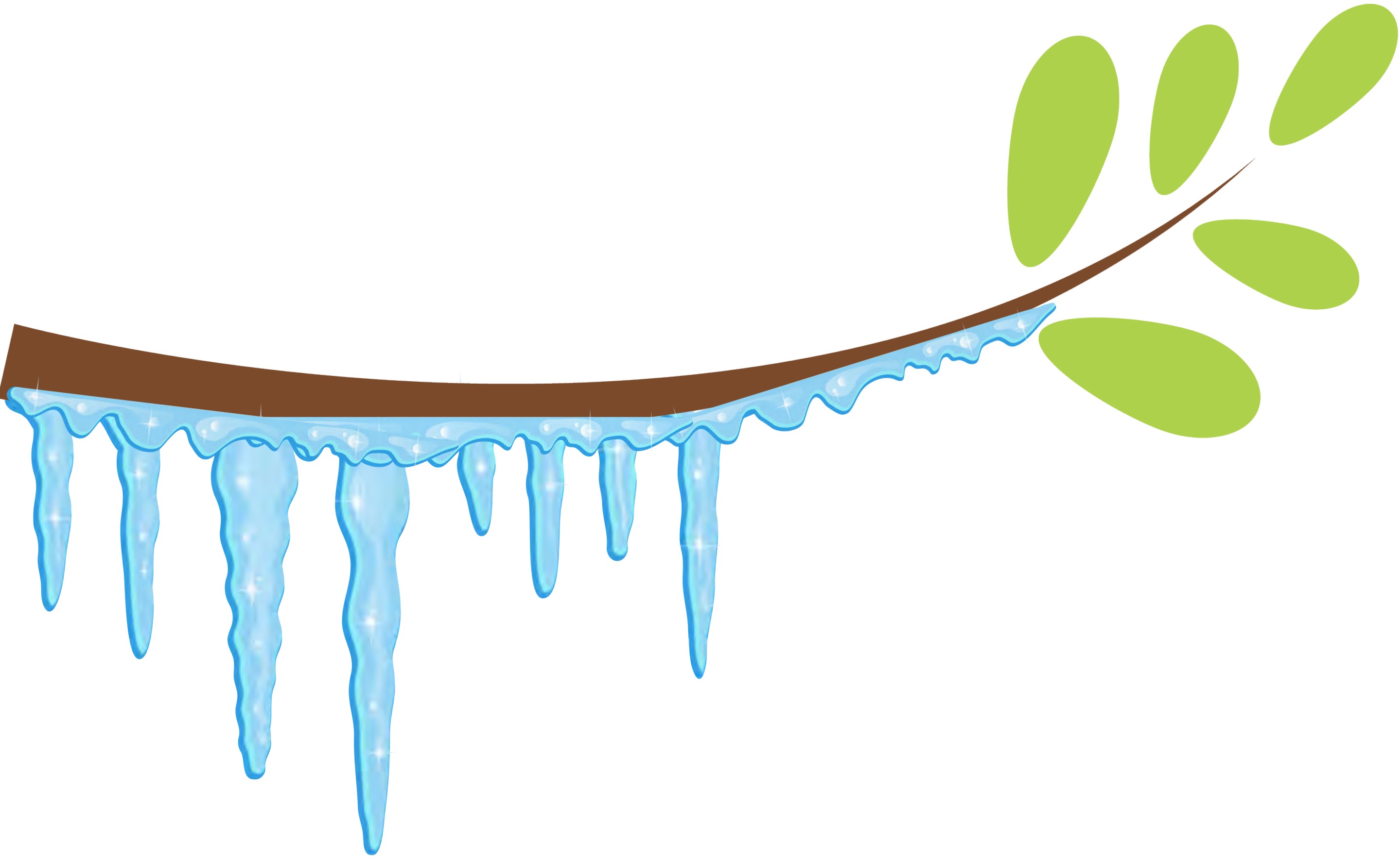
You Might Also Like:











Frosted Forest

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.

Frosted Forest 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:**
  - White construction or copy paper (3-8 pages)
    - 7 triangle templates are included, or students can create their own triangular icicles in a computer program or by hand.
  - Pipe cleaners (5 - 8)
  - Craft sticks (5 – 8)
  - Straws (5 – 8)
  - Small paper cups (4 – 6), cardboard tubes, and/or cardboard scraps
  - Scissors (ideal for each student to have his/her own)
  - Masking or clear tape (1 roll/group; don't limit the tape)
  - Rulers (ideal for each student to have his/her own)
  - Design analysis & data recording handouts
  - Optional
    - Protractors (if measuring angles; ideal for each student to have his/her own)
    - Folders, Ziploc bags, or large envelopes to contain triangle cutouts if working on multiple days.
    - Calculators (for younger students and/or those with special needs to calculate point values)

Note: You may choose to eliminate some of the materials the students may use for the tree (pipe cleaners, straws, cups, cardboard), but the more you include, the more variety you'll see in their designs.

Video Walk-Through

The image below is linked to the Winter/Christmas playlist on my YouTube channel, where you can find this video walk through.

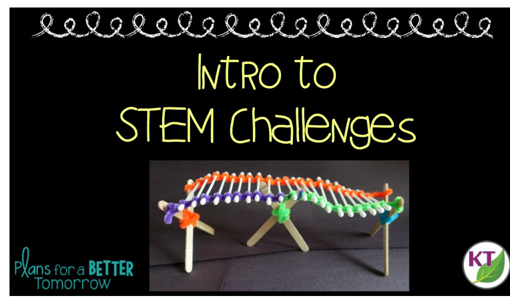
Note to Teachers

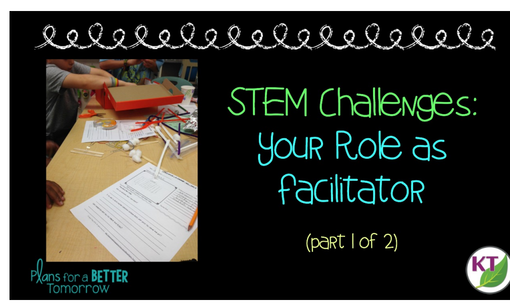
The beauty of STEM Challenges is that they are open-ended and require critical thinking and problem-solving. This is why we don't give students directions to build a specific design. In keeping with the engineering design process, a criteria & constraints list is provided to give students a framework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





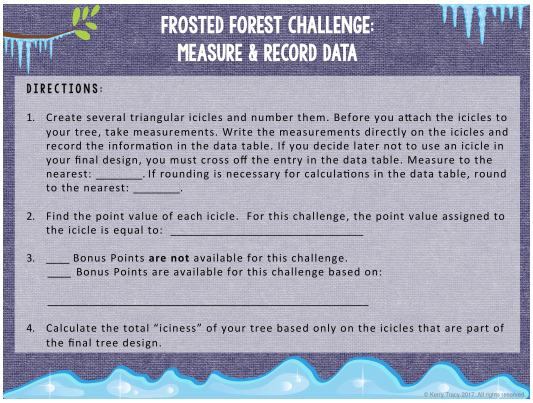
You can also find my full video library & newest PD on:

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

- **Premise**
  - In partners/small groups, students will design the "iciest" tree possible.
    - Using a criteria/constraints list, students will build a tree with branches. They will also create triangular icicles to attach to the branches. Point values are assigned to each triangle based on various criteria (dependent on age group). Students attempt to create the iciest tree possible in the class's Frosted Forest.
  - This challenge can be run simply (focusing on shape creation & manipulation, measurement, and addition), or you can add complexity (focusing on triangle classification by sides and angles, layering icicles, assigning point value based on area, etc.). Two editable criteria/constraints lists are provided to highlight either end of the spectrum.
  - Plan to give students approximately ~40 min. to design, ~20 min. to measure and share results, ~15 to complete design analysis slides, and ~15 minutes for group discussion. Timing will vary based on the level of complexity you choose for the challenge. Additional time will be needed if you are assigning extension activities.

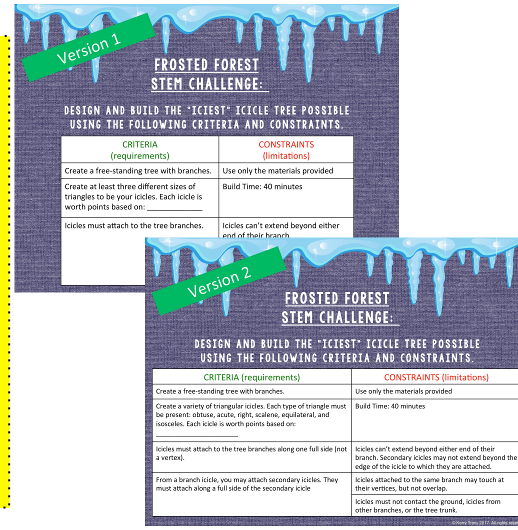
- **Set Up**
  - Watch the challenge walk-through video. This is highly recommended as it will make reading the rest of this easier or unnecessary!
  - If you are new to STEM challenges, watch one or more videos on the previous page.
  - Decide how you want students to assign point values to the triangles. (Details/ suggestions in "Measuring Results" (pg. 3 of Teacher Tips).
  - Depending on the variety of triangles and types of measurements and calculations you ask students to perform, this challenge could take more than one lesson to complete.
    - To create the triangles, you can have students use the templates provided, draw on blank paper using a ruler, create in PowerPoint or another program and print, or use a combination of approaches.
    - Consider devoting the first lesson to creating a tree and creating/measuring icicles, and the second to finishing measurements, attaching icicles to trees, recording/analyzing data, and discussion.
  - It is included in the student directions, but be sure to stress to students they should take measurements *before* attaching icicles to branches.
  - Decide if you will make any modifications to the Criteria & Constraints List.
  - Fill in blank spaces on student directions and Criteria & Constraints Lists (details on the next page).

- **Set Up (continued)**



On the Measure & Record Data Directions slide, type in how to take measurements and round calculations in #1. Type in how to calculate point values of icicles and optional bonus points in the blank spots for #2 & #3.

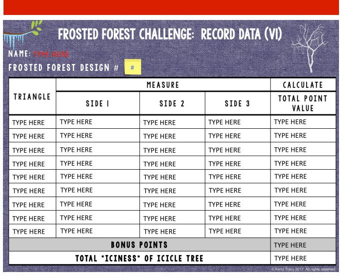
Fill in the blank on the Criteria & Constraints List & make any additional adjustments desired before assigning to students.



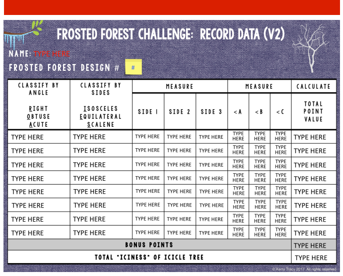
- **Criteria/Constraints**
  - Two editable versions of the Criteria/Constraints lists have been provided: the first is simpler for younger students; the second is more advanced.
  - If you intend to display the trees as a Frosted Forest, you may want to add a footprint or length x width x height constraint to ensure you can fit them all!
  - To *decrease* the difficulty of the challenge (or to save time):
    - Increase build time.
    - Use the first Criteria/Constraints List.
    - Add a constraint to limit the total number of icicles used on the tree.
    - Use triangle templates rather than creating with paper/pencil or a computer program.
  - To *increase* the difficulty of the challenge:
    - Decrease build time.
    - Use the second Criteria/Constraints List.
    - Have students create their own triangles on PowerPoint or another program, but constrain the number of pages they're allowed to print off. Provide one additional sheet of blank paper during the build, so they can hand draw a few replacement icicles, if desired.
    - Add a criterion/constraint for percent contribution of one or more triangle type(s) to the total. This can be calculated by point values associated with the triangle types vs. total points of the design, or the number of triangles of that type vs. total # of triangles in design.
      - Example: Right triangles must account for at least (or no more than) 40% of the design.
    - Change the challenge to 3-D by creating icicle cones and calculate point values based on volume.

- **Measuring Results**
  - Students should verify they have met all listed criteria/constraints. If an icicle violates a constraint, its points do not count toward the total.
  - As shown on the previous page, there is an editable set of student directions where you will type in directions for how students will record measurements, assign point values, and accrue bonus points (optional).
    - Decide how students will measure their triangles – centimeters, to the nearest inch, ½ in., ¼ in., etc.
    - Decide if calculations or point values should be rounded to whole numbers, tenths, hundredths, etc.
  - **Point Value Options:**
    - Points = longest side of triangle
    - Points = perimeter of triangle
    - Points = area of triangle
    - Points = perimeter + area (round each value to whole numbers prior to adding)
  - **Bonus Point Options:**
    - One point for every icicle used
    - 3 points for every obtuse triangle; 2 points for scalene, etc.
    - Find the branch worth the highest number of points. That branch's value is the bonus point value.
    - Create your own!
  - There are four versions of student data recording provided (shown below) in increasing order of difficulty based on the types of measurements/calculations required.

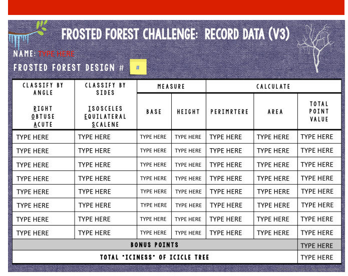
V1



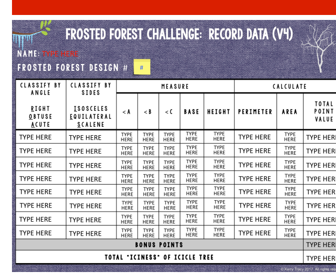
V2



V3



V4



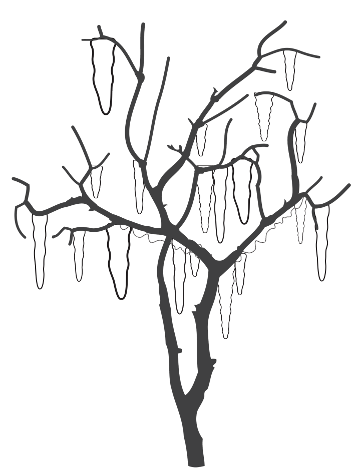
Have students duplicate the data recording slide as needed.

  - **Note: If you have very young students or students with special needs, consider allowing them to use calculators to help with calculations.**

- **Post-Design Options**
  - Design analysis (slides included)
  - Discussion questions (slides included)
  - Re-design and re-test (consider incorporating new, student-suggested materials).
  - Extension activities
    - Research plant adaptations.
      - Excellent Evergreens (Video ~5 min.) [2nd – 5th]
      - Plants That Keep Themselves Warm (Video ~4 min.) [6th – 8th]
      - How Plants Tell Time (Video ~4 min.) [6th – 8th]
      - Snow and Plants (Article) [5th – 8th]
    - Learn about stalactites & stalagmites. Compare/contrast with icicles.
      - Caves: An Intro for Kids (~5 min.) [2nd – 5th]
      - Make a Stalactite v1 (~3 min.) [2nd – 5th]
        - » Try adding food coloring and/or using different types of rope for variety
      - Make a Stalactite v2 (~1 min.) [2nd – 5th]
    - Practice classifying triangles (slide included in "Extension Templates")
    - Close read this article on icicle shape. (~6th – 8th)
    - Watch instructional videos to learn and practice constructing triangles with various criteria/constraints. (~7th-8th)
      - Download this free worksheet for extra practice.
    - Ask students to review the data tables for every group. (You may want to copy the data tables of each group and send to all for analysis post-design, or simply post data tables in a central place, preferably along with photos of their icicle trees.) Have students use the data to discuss and defend their answer to the following:
      - Which factors led to the "iciest" icicle tree designs: fewer, larger icicles; many smaller icicles; more/fewer right, obtuse, acute, isosceles, scalene, equilateral triangles; number of branches, branch length, or some other factor?
      - Ask students: If the way we calculated point value of the icicles was changed to (insert example you didn't use from the options on the previous page), do you think the current "iciest" trees would remain the "iciest"? Why or why not? Have students recalculate point totals based on the new rule to validate.

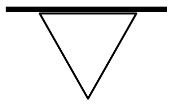
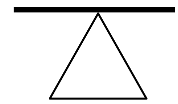
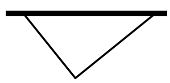
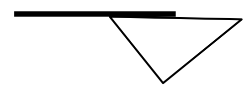
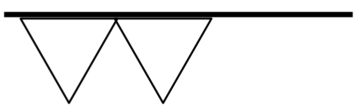
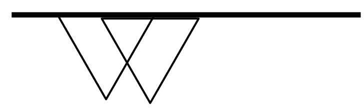
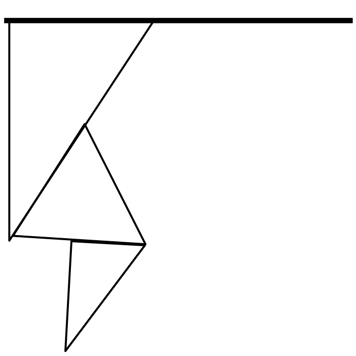
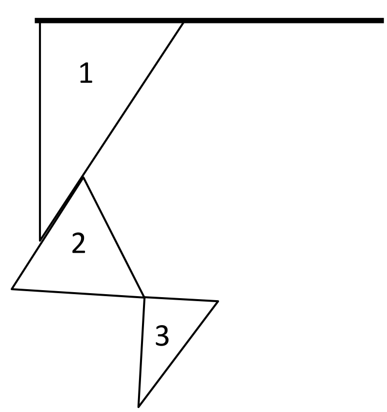
Note: One slide per video/website is included in the student slides with its link, so you can easily assign to students.

- **Post-Design Options (continued)**
    - Create graphs using data tables:
        - Students discuss in their groups how they could use a graph - of any kind - to communicate their data or whole-class data. Have students brainstorm what they could graph (use ideas from the factors they think led to the iciest trees) Students create and share graphs. Peers give each other feedback on the value of the graphs in communicating information.
            - » Examples of data to graph:
                - % contribution of triangle classifications to total # icicles
                - Number of branches (or some other factor) vs. total point value
            - » Note: Some groups may choose the wrong graph type to share their data. For this activity, I would let them move forward, because there is value in letting students create a "bad" graph. People learn from mistakes and trial/error. Furthermore, it provides all students the opportunity to think critically and analyze graphs when providing peer feedback. Feel free to disagree, and have students get your approval before starting their graphs.
            - » Another Option: If there is a particular type of graph you want students to practice, ask students what data fits the graph well. Example: "What information from this challenge could be shared using a pie chart?"
    - Ask students if they think they could create an "icier" tree with a different shape for the icicles. Have them re-do the challenge with the shape of their choice.
    - Students create a process flow map for how to make their icicle tree 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).



EXAMPLES & NON-EXAMPLES OF APPROVED ICICLE ATTACHMENTS

For Second Criteria & Constraints List Only. Student Slide Included.

EXAMPLES	NON-EXAMPLES
	Connects at vertex 
	Extends beyond the branch 
	Overlapping icicles 
	Triangle 2 doesn't connect on a full side & extends past edge of triangle 1. Triangle 3 connects at vertices rather than sides. 

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

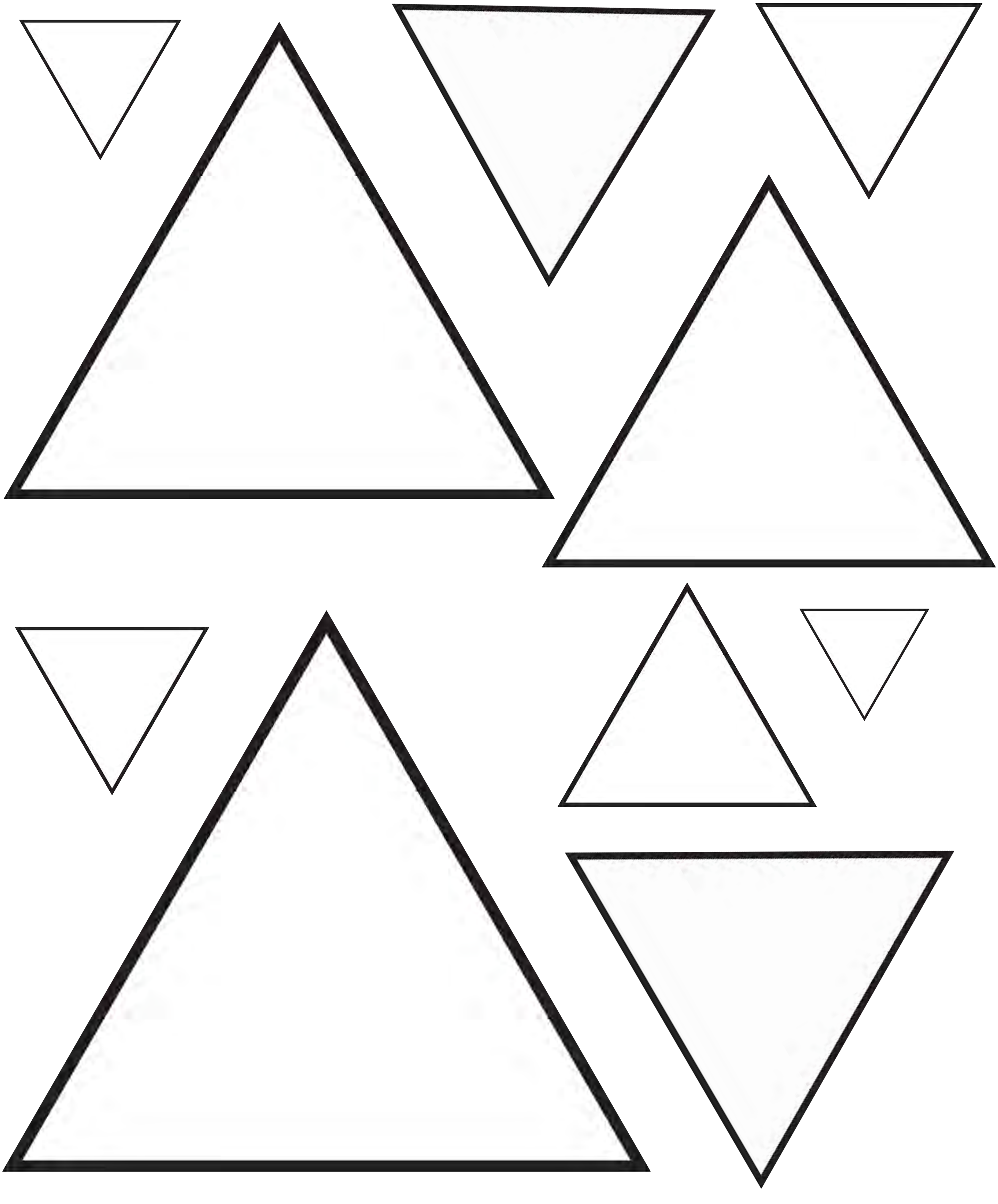
Post-Design – Design Analysis Slides

- 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).

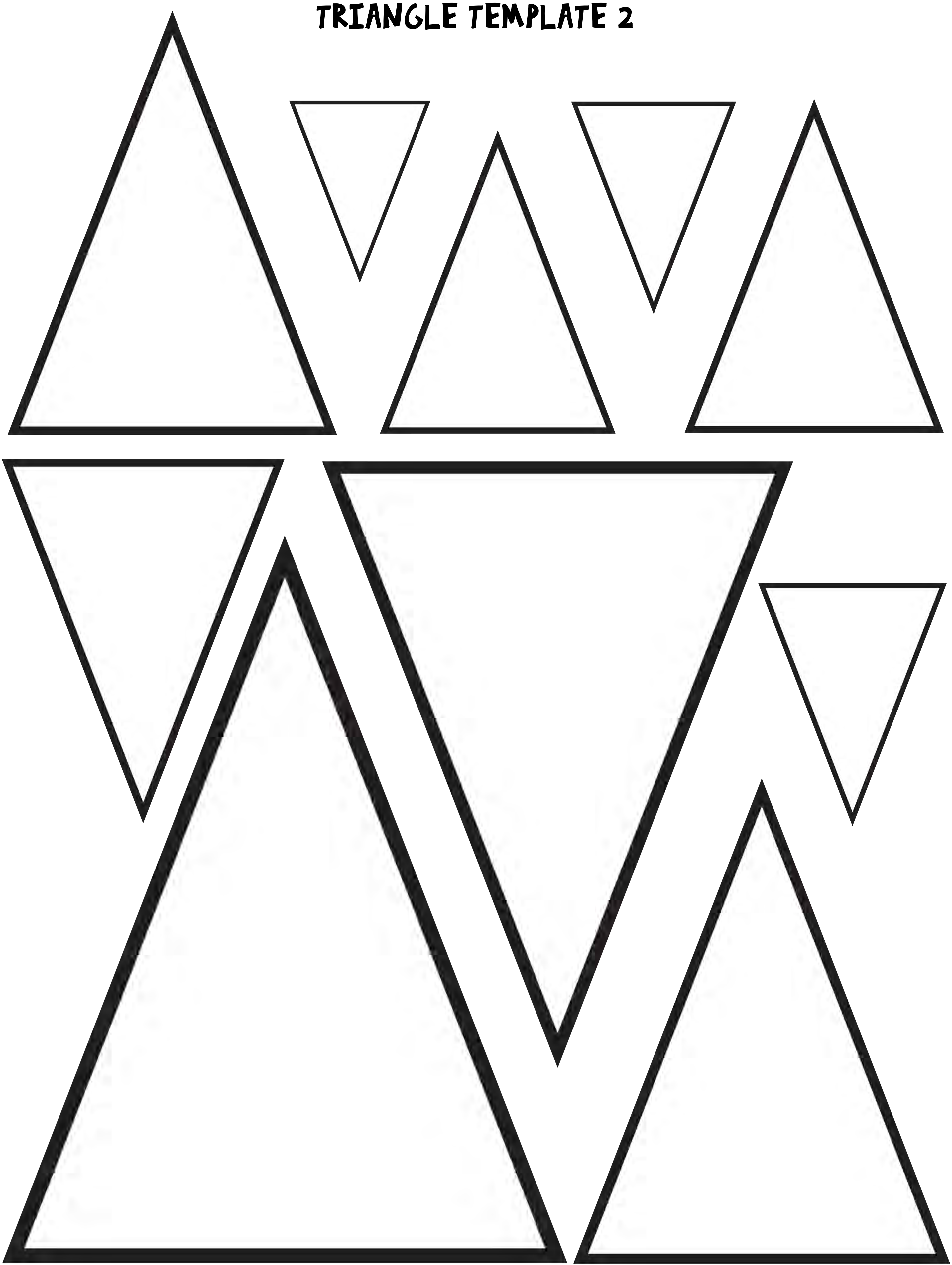
Grades
2 - 8

Triangle & Cone Templates

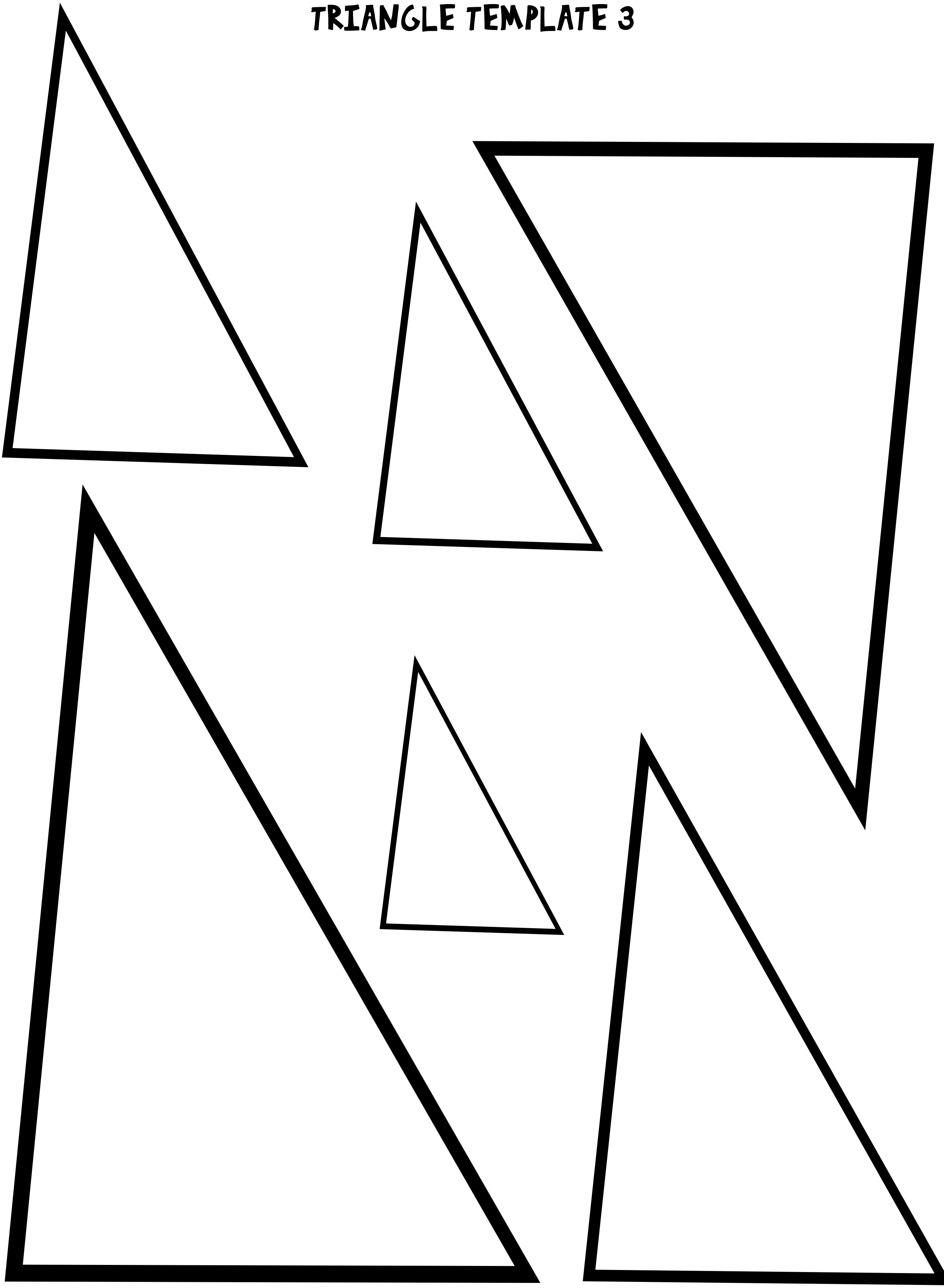
TRIANGLE TEMPLATE 1



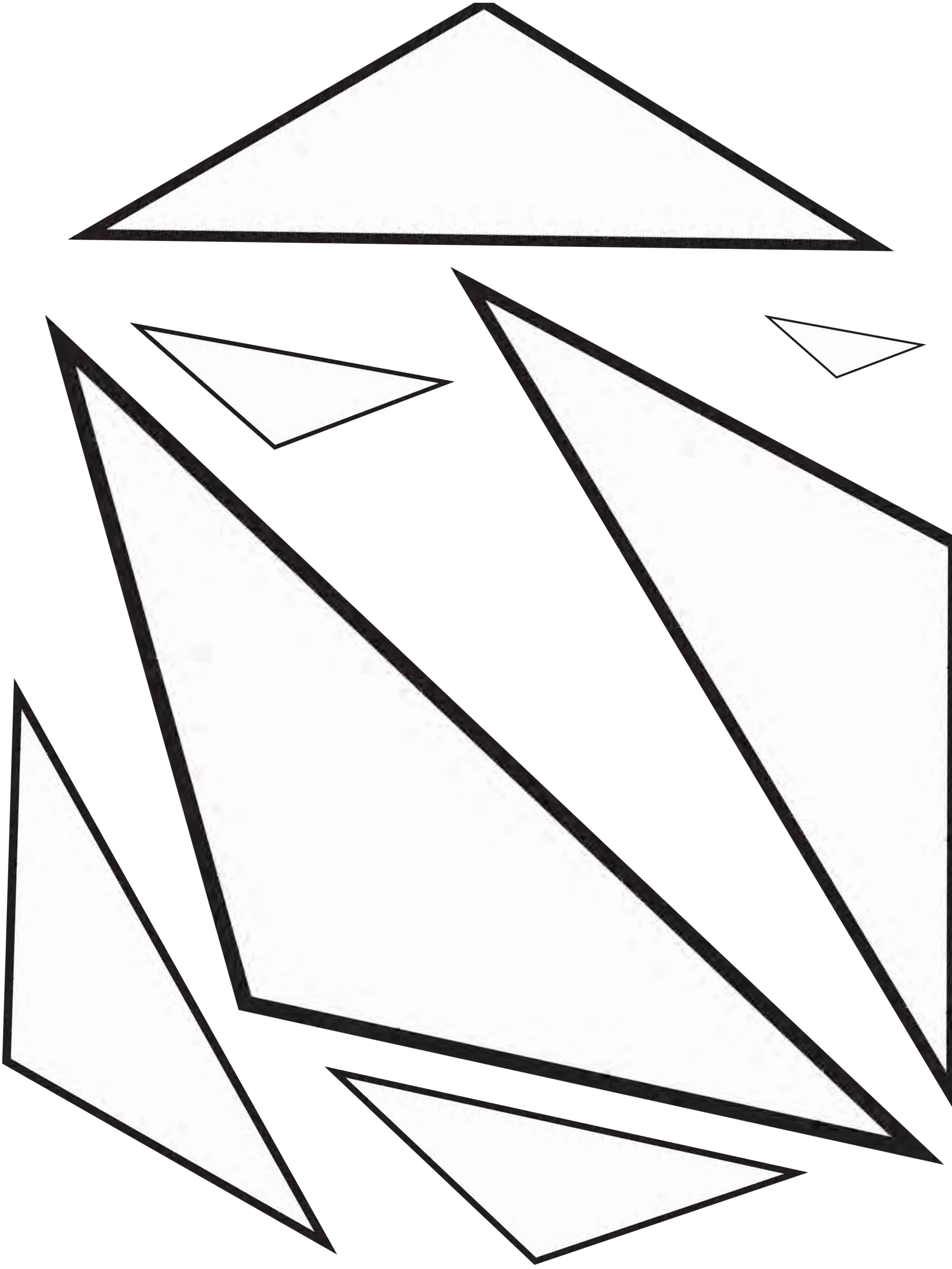
TRIANGLE TEMPLATE 2



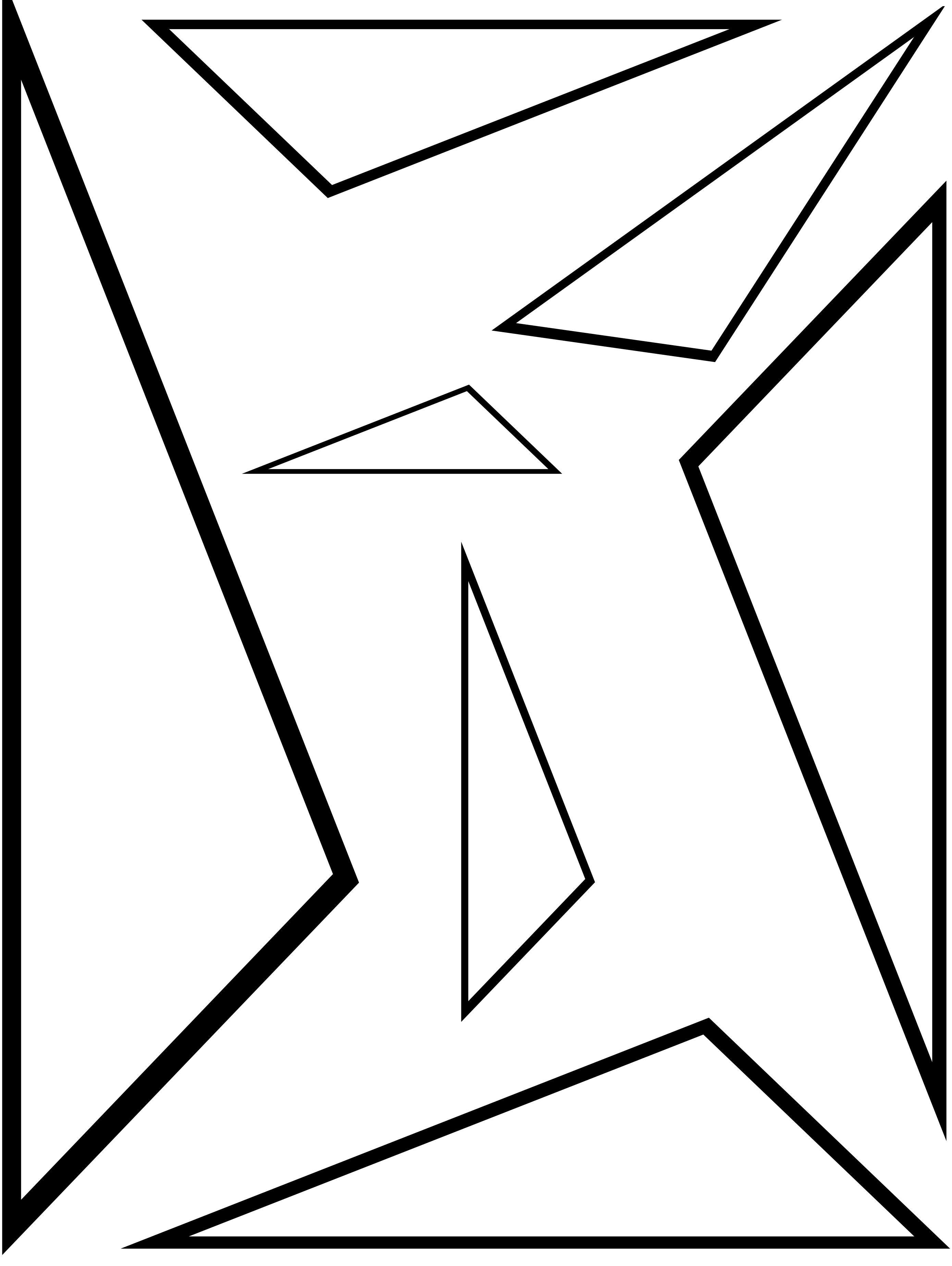
TRIANGLE TEMPLATE 3



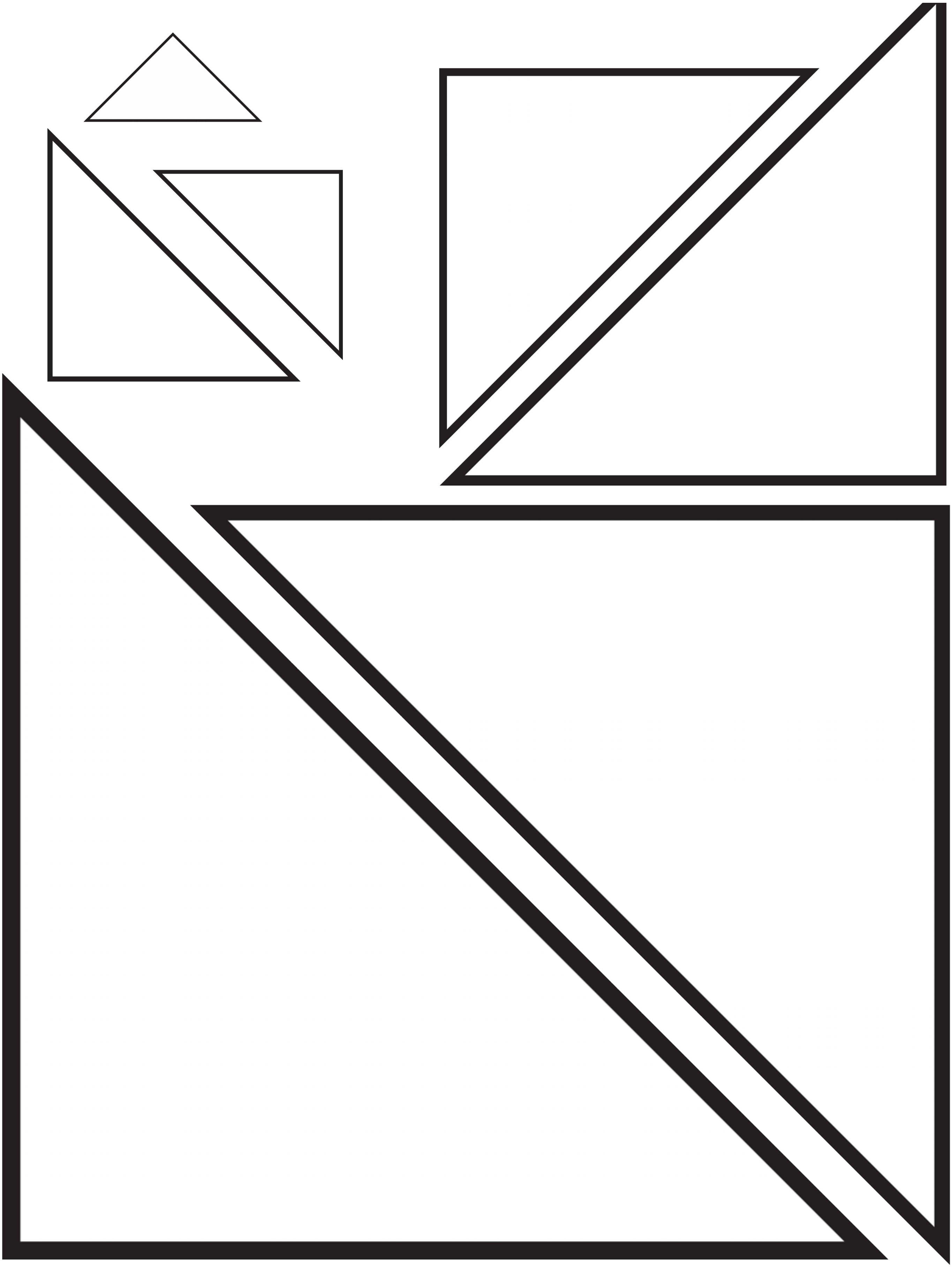
TRIANGLE TEMPLATE 4



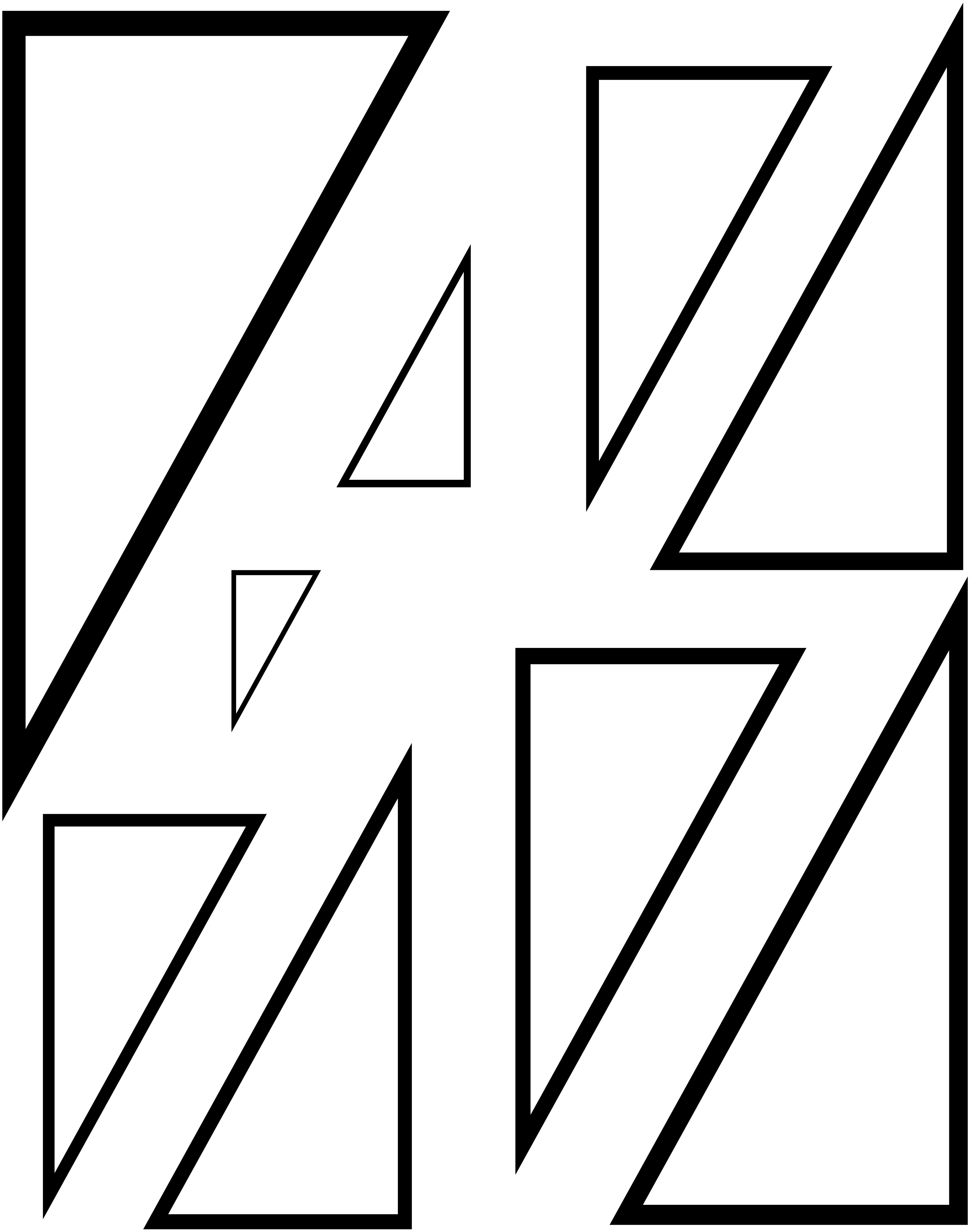
TRIANGLE TEMPLATE 5



TRIANGLE TEMPLATE 6



TRIANGLE TEMPLATE 7



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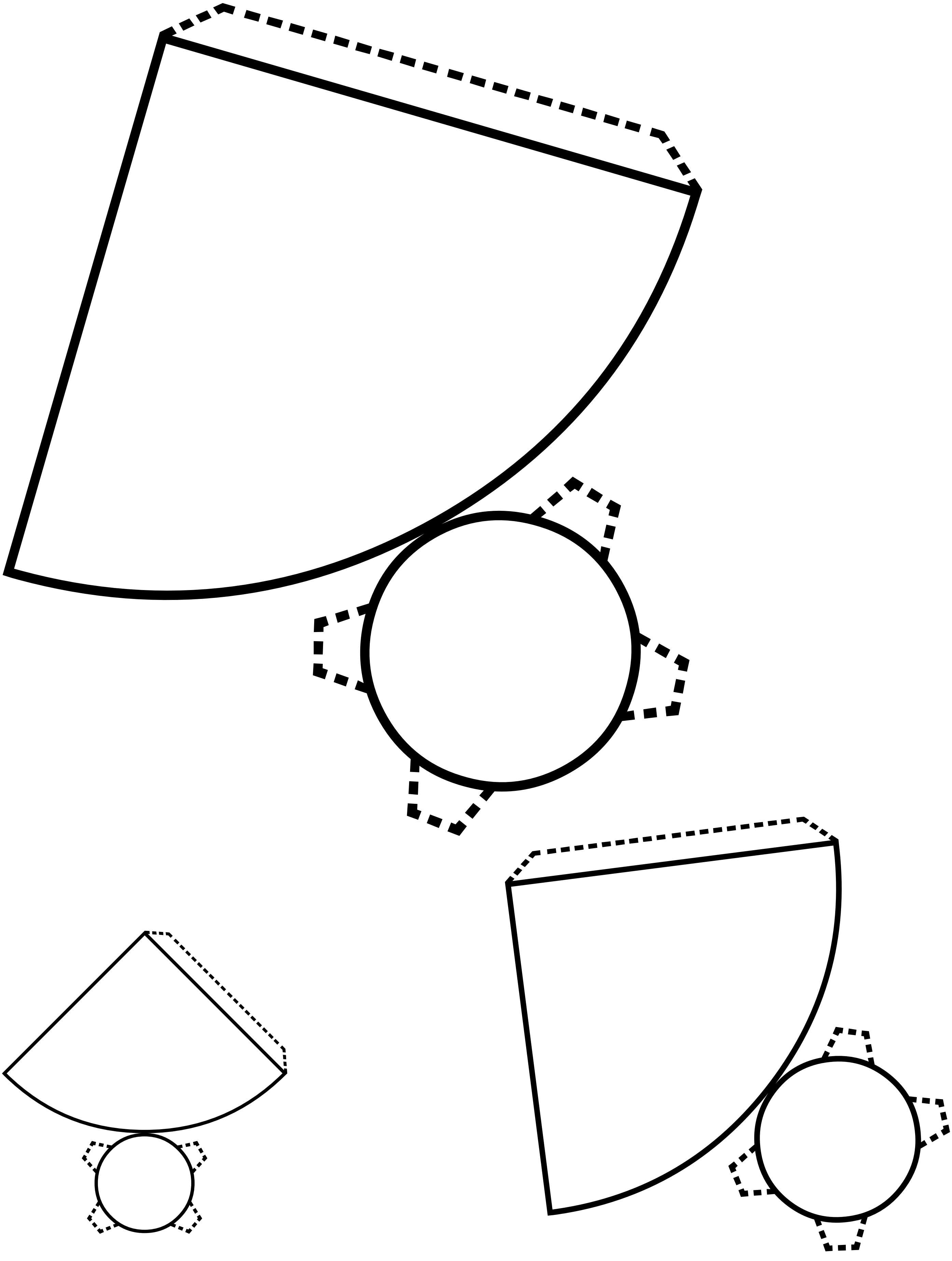

Next Generation Science Standards (NGSS)

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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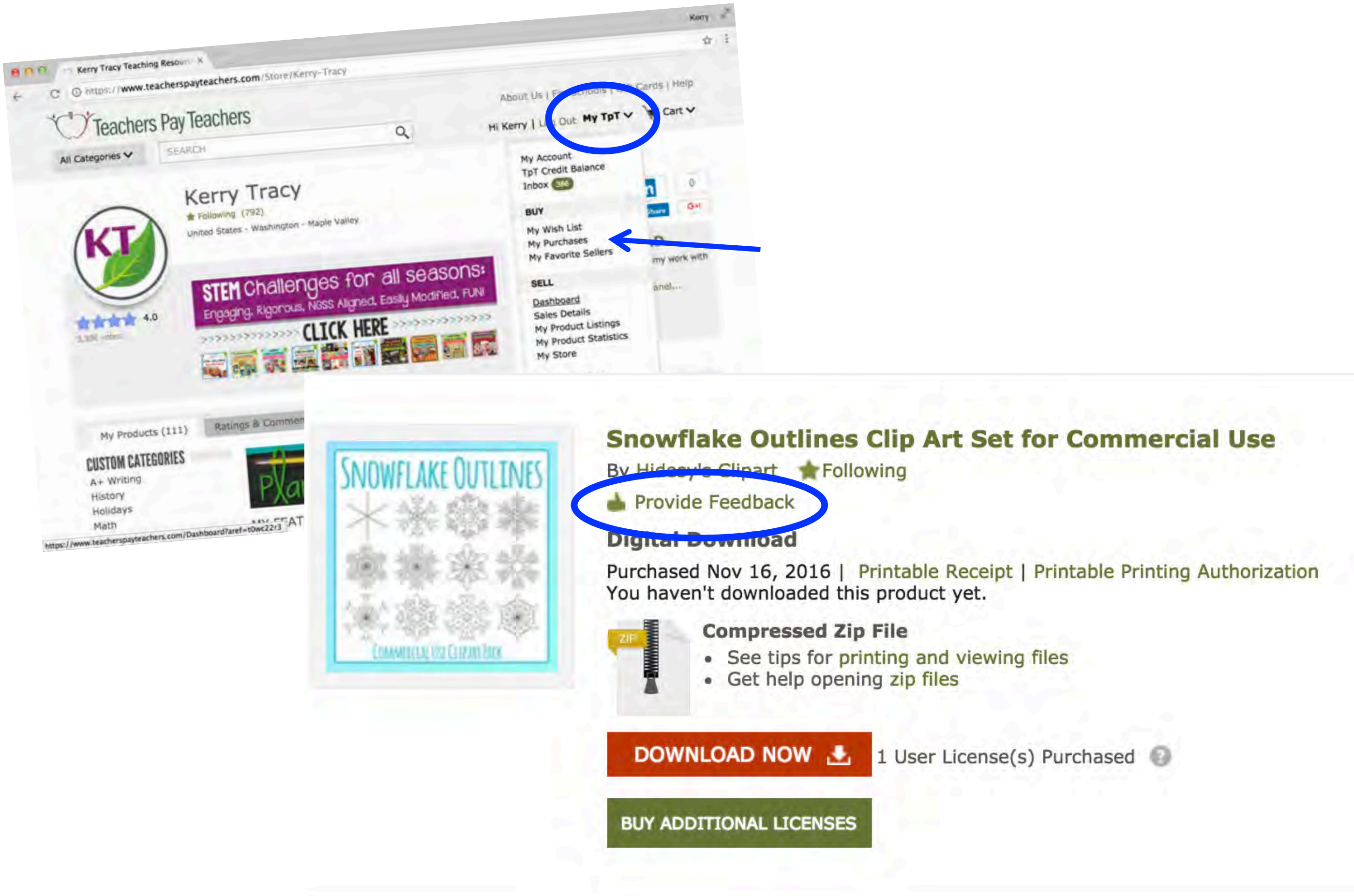

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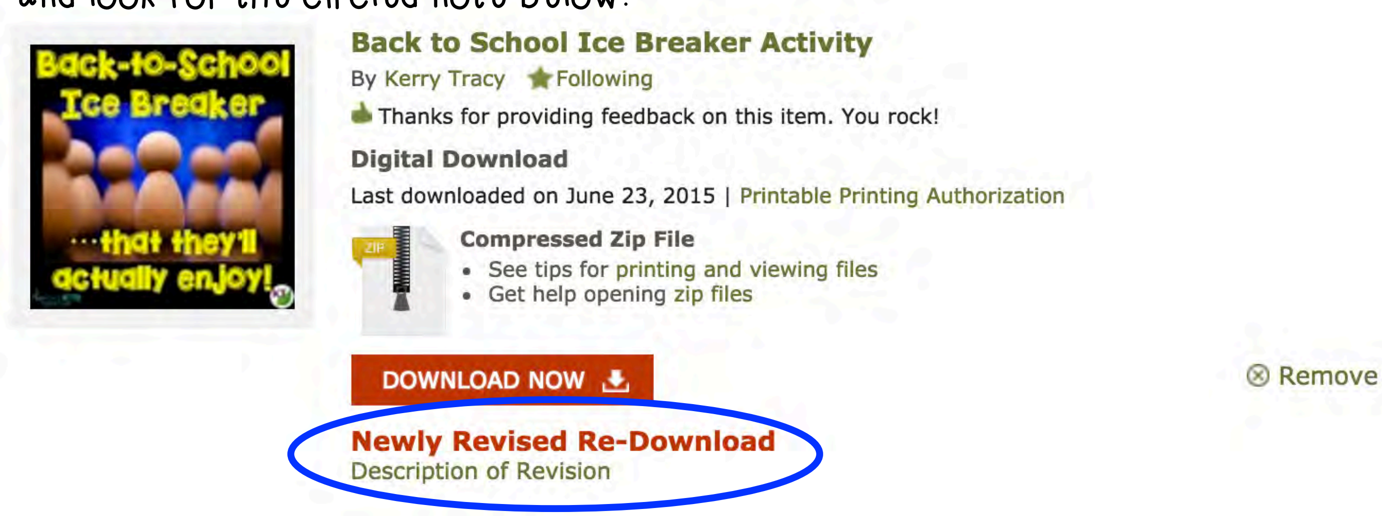

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