PREP Alternative

Week 1: Learning to Learn

June 15 – June 21, 2020

Weekly Objective: The aim of this week is to help participants understand how to best learn new material and retain and apply their understanding as they progress through this program and embark on future coursework.

Instructions: The following lessons are cumulative and participants are encouraged to complete one or two lessons a day in order, first identifying a STEM topic that interests them, then finding print and/or digital media (e.g. articles, books, documentaries) to study. Each lesson refers to a step in the Study Cycle (see page 2) and specific instructions and handout(s) are provided.

PACKET CONTENTS

The Study Cycle

Learning to Learn

PREP Alternative

Week 1: Learning to Learn

Lesson 1: Preview

Instructions: After you have identified a STEM topic of interest, select 3-4 sources for research on that topic. These items can be print or digital media and include articles, books, encyclopedia entries, and documentaries, etc. For each of these items, complete the following worksheet.

SOURCE 1

Resource Name/Title:

Resource Type (Book, article, documentary, etc…):

List Heading/Chapter/Section Titles (if any):

List and describe images/graphs/charts (if any):

One-sentence summary of concluding paragraph/monologue:

Write one question you have about the content of this source before reading it:

SOURCE 2

Resource Name/Title:

Resource Type (Book, article, documentary, etc…):

List Heading/Chapter/Section Titles (if any):

List and describe images/graphs/charts (if any):

One-sentence summary of concluding paragraph/monologue:

Write one question you have about the content of this source before reading it:

SOURCE 3

Resource Name/Title:

Resource Type (Book, article, documentary, etc…):

List Heading/Chapter/Section Titles (if any):

List and describe images/graphs/charts (if any):

One-sentence summary of concluding paragraph/monologue:

Write one question you have about the content of this source before reading it:

SOURCE 4

Resource Name/Title:

Resource Type (Book, article, documentary, etc…):

List Heading/Chapter/Section Titles (if any):

List and describe images/graphs/charts (if any):

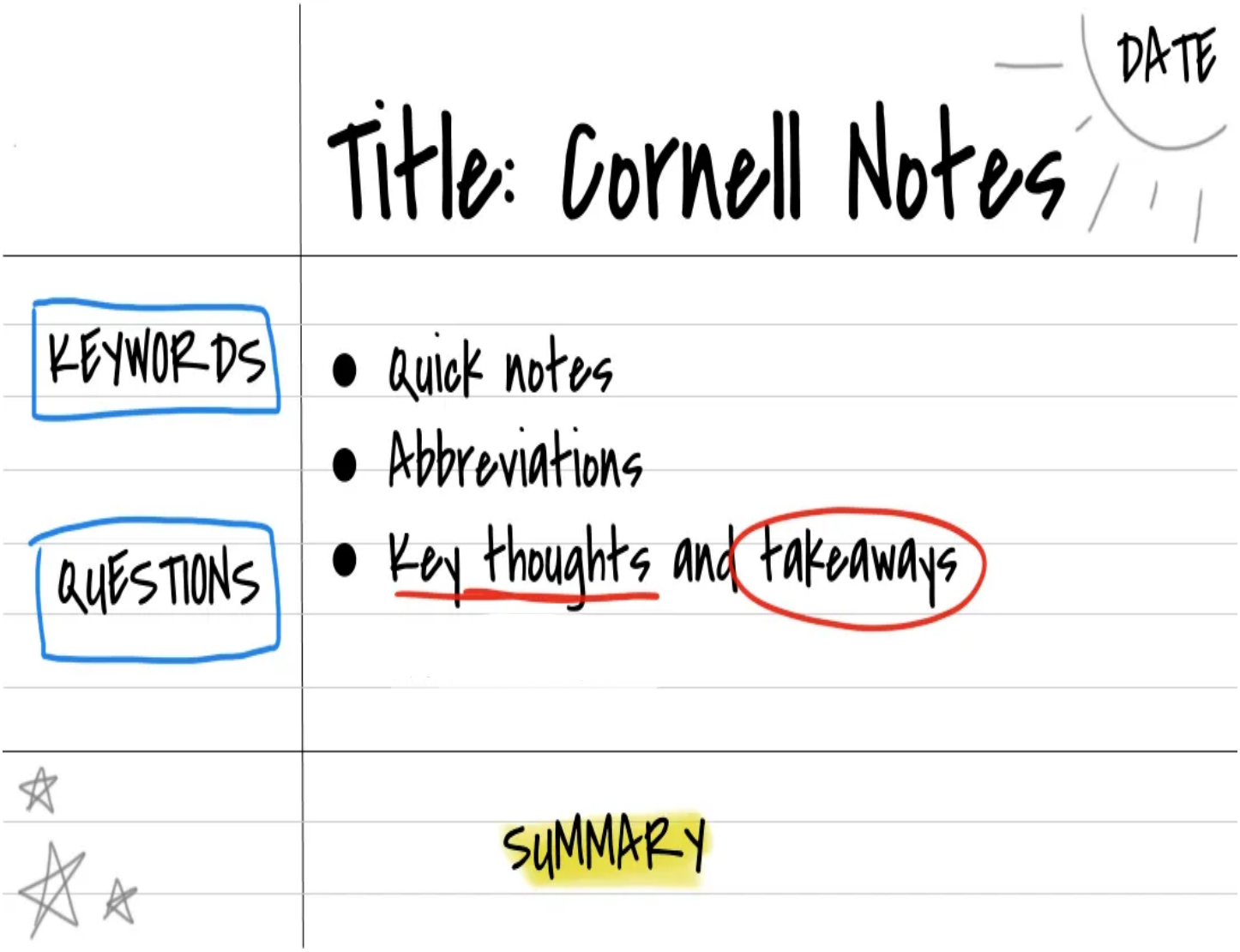
One-sentence summary of concluding paragraph/monologue:

Write one question you have about the content of this source before reading it:

Lesson 2: Read (or View) & Take Notes

Instructions: After you have completed Lesson 1, you will have some idea of the content of your sources. Now it is time to read or view—strategically. This means you are engaging with your sources with purpose. Specifically, as you read an article or view a digital clip or documentary, you are paying attention to key words and ideas and writing them out using your own words. Additionally, as you move through the source, if you do not understand something, you are making note of it or writing out questions.

Please view the following sample of a type of notetaking. Then as you read or view each of your sources, create and fill in a Cornell note page with your own notes and questions. Additionally, reflect on whether you are now able to answer your question for each source from the previous lesson.



Lesson 3: Review

Instructions: You have now read/viewed and taken notes on your source materials. The next step is to review. Reviewing notes and taking a second or third look at your sources can help you answer any questions or fill in "holes" in your understanding of your selected STEM topic. As you look at your notes, keep in mind you may have to seek out new sources or find definitions to concepts or words. To complete this lesson, use your work from lessons 1 and 2 to fill out the following worksheet.

SOURCE 1

Source Title:

Identify 3-4 major concepts included in this source:

What were your questions listed in your notes and what are the answers:

Rewrite your summary, integrating the concepts and answers above:

Finally, what major concepts or ideas from this source are consistent with concepts or ideas from your other sources:

SOURCE 2

Source Title:

Identify 3-4 major concepts included in this source:

What were your questions listed in your notes and what are the answers:

Rewrite your summary, integrating the concepts and answers above:

Finally, what major concepts or ideas from this source are consistent with concepts or ideas from your other sources:

SOURCE 3

Source Title:

Identify 3-4 major concepts included in this source:

What were your questions listed in your notes and what are the answers:

Rewrite your summary, integrating the concepts and answers above:

Finally, what major concepts or ideas from this source are consistent with concepts or ideas from your other sources:

SOURCE 4

Source Title:

Identify 3-4 major concepts included in this source:

What were your questions listed in your notes and what are the answers:

Rewrite your summary, integrating the concepts and answers above:

Finally, what major concepts or ideas from this source are consistent with concepts or ideas from your other sources:

Lesson 4: Reorganize

Instructions: At this point, you have read and reviewed your source material and begun synthesizing or putting together what you have learned by recognizing common concepts or ideas in all of your sources. The process of reorganization encourages you to further synthesize your knowledge of your chosen STEM topic by fulling combining all of your notes, questions, and summaries. For this lesson, complete the following activities to help you better retain information and develop your comprehension of your topic.

ACTIVITY #1
Flashcards

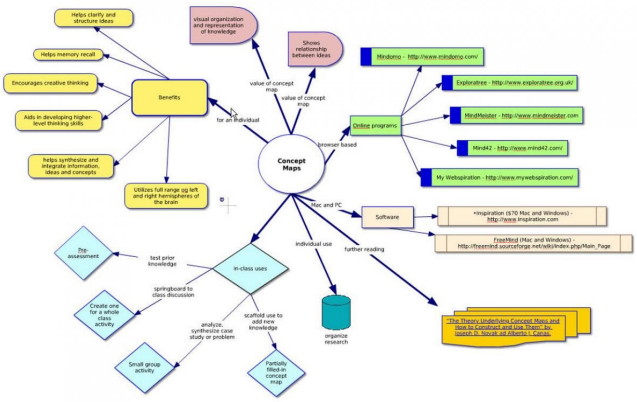
Perhaps one of the simplest study strategies, creating and using flashcards helps solidify your understanding of basic concepts and words you have just learned. For this activity, you can use either pre-cut index cards or cut blank pieces of paper into equal-sized squares to write your words/questions on one side and definitions/answers on the other. Dedicate at least five cards each to the following categories:

1. Definitions: Identify single words with which you are not familiar, writing the word on one side and meaning on the other.
2. Simple Questions: This includes information on measurements, formulas, locations, identifying type or category. Questions would typically start with "what is/are," "how many," "what kind," etc.
3. Making Connections: Identify dependencies between concepts. On one side of a blank card, write the concept followed by either "influences" or "is influenced by" and on the other side, create a list of concepts or ideas that completes that statement.

Review your cards, spending no more than 45 minutes at a time practicing with them to test your knowledge.

ACTIVITY #2
Concept Mapping

A concept map is a visual representation of your knowledge of a topic. At the center of a large piece of paper, write in a few words describing your chosen STEM topic and draw a circle around it. Then, using your flashcards from Activity #1, write those topics/words/concepts on various locations around the center of the page. Add any other words or ideas that are relevant. Once done, draw lines between connected topics/words/concepts. On a separate piece of paper, for each line, write one sentence describing the relationship between the connected topics/words/concepts. Your concept map may look something like this:



Lesson 5: Practice & Self-Quiz

Instructions: For this lesson, you will need all your sources, notes, and materials from Lesson 4. First, practice your knowledge by pairing with a friend or family member to discuss your STEM topic and previous activities. Allow your discussion partner to ask you questions about your topic. Take notes on this discussion, writing down your partner's questions. These questions will be used to develop your self-quiz.

Self-quizzing is a good strategy for challenging your understanding and practicing for exams. Your quiz should consist of 10 questions, at least one from each of the categories (below) and four additional questions from your choice of category. On a piece of paper, write out your questions. Use your notes from your sources and discussion, flash cards, concept map, and source materials to create these questions. Once done, take a break, put away your materials, find a quiet place and give yourself 30 minutes to take your quiz. Once time is up, review your answers and compare them to what is in your notes and sources Note what was and was not accurate and why.

Bloom's Levels of Questioning - Generic Question Stems for Science & Math

1. REMEMBER - recalling information

What information is given?
What are you being asked to find?
What formula would you use in this problem?
What does _____mean?
What is the formula for...?
List the...
Name the...
Where did...?
What is...?
Who was/were...?
When did...

2. UNDERSTAND - comprehending meaning

What are you being asked to find?
Explain the concept of...
Give me an example of...
Describe in your own words what _____ means
What (science or math) concepts does this problem connect to?
Draw a diagram of...
Illustrate how _____ works.
Explain how you calculate...

3. APPLY - using learning in new situations

What additional information is needed to solve this problem?
Can you see other relationships that will help you find this information?
How can you put your data in graphic form?
What occurs when..?
How would you change your procedures to get better results?
What method would you use to...
Does it make sense to...?

4. ANALYZE - ability to see parts & relationships

Compare and contrast _____ to _____
What was important about...
Which errors most affected your results?
What were some sources of variability?
How do your conclusions support your hypothesis?
What prior research/formulas support your conclusions?
How else could you account for...?

5. EVALUATE - judgment based on criteria

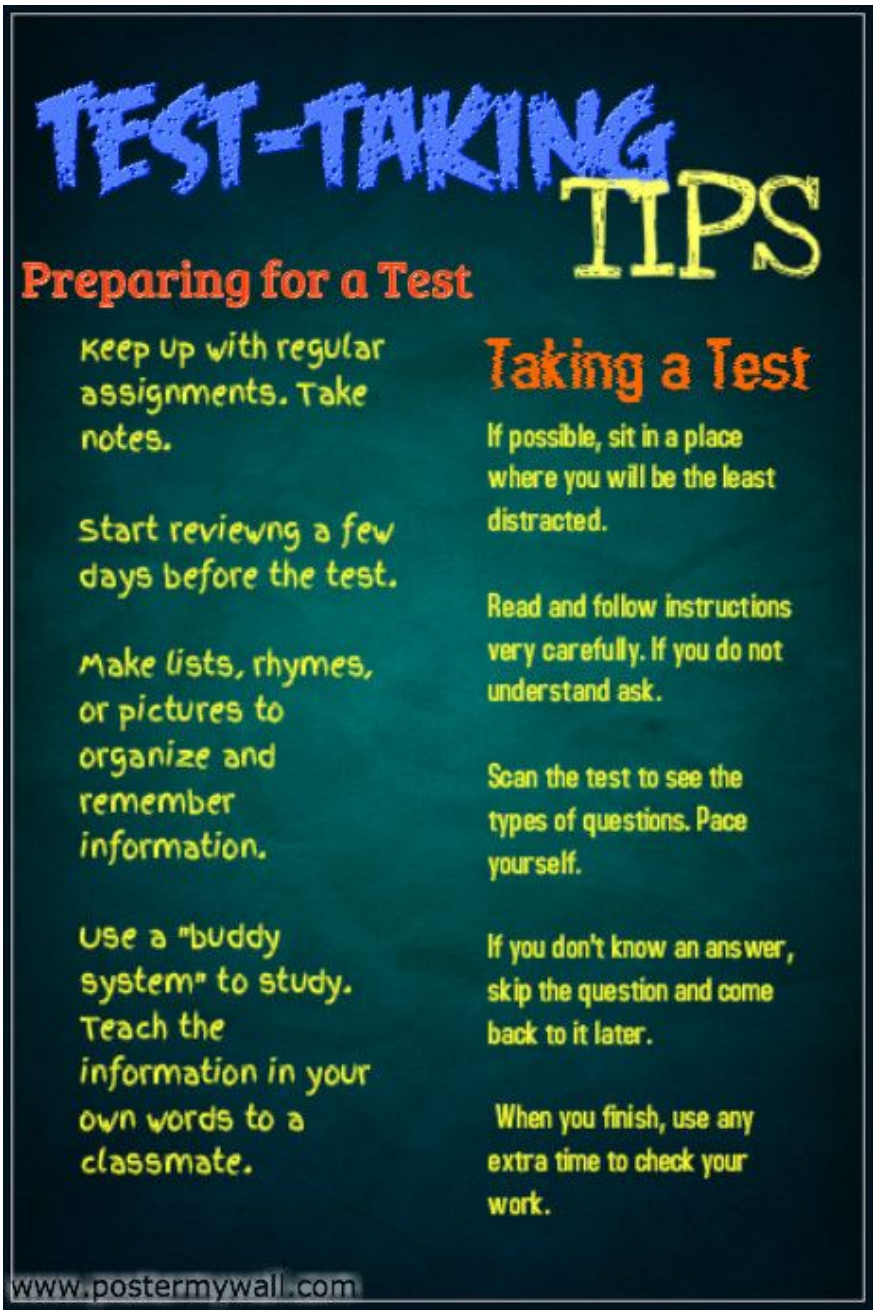
How can you tell if your answer is reasonable?
What would happen to _____ if _____ variable were increased/decreased?
How would repeated trials affect your data?
What significance is this experiment /formula to the subject you're learning?
What type of evidence is most compelling to you?
Do you feel _____ experiment is ethical?
Are your results biased?

6. CREATE - parts of info to synthesize new whole

Design a lab to show...
Predict what will happen to _____ as _____ is changed
Using a principle of (science or math), how can we find ...?
Describe the events that might occur if...
Design a scenario for...
Pretend you are...
What would the world be like if...

Lesson 6: Testing

Instructions: To complete this lesson, review the following tips regarding test-taking. Answer the subsequent questions.



1. What strategies listed have you used? Which helped and which did not?
2. What are other test-taking strategies you have tried that worked for you?
3. Why do you think some strategies work for you and others do not?

Lesson 7: Reflection & Planning

Instructions: For this lesson, you will need materials from lessons five and six. The purpose of this lesson is to review your self-quiz performance and assess what activities and behaviors helped you learn more about your STEM topic. Answer the following questions honestly to strategize for the next study cycle.

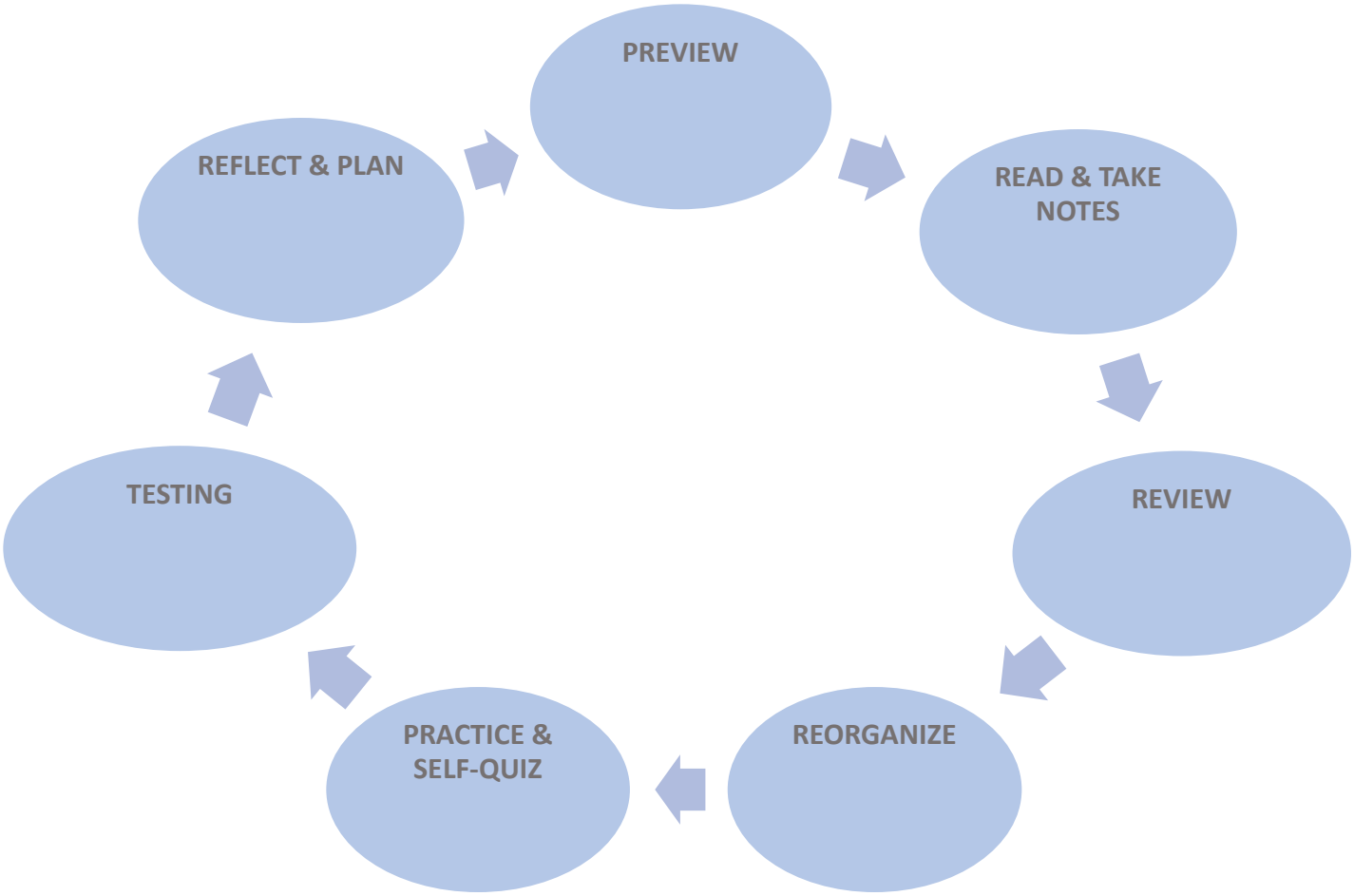
1. On a scale of 1 to 10 (1 = Poor and 10 = Excellent), how would your rate your answers to questions during your discussion and on your self-quiz from lesson 5. Why do you deserve this rating?

2. Of the various concepts/ideas you identified from sources which do you feel you understand the most and which do you understand the least? How much time do you think you spent reviewing and studying each individual concept/idea? Is there a connection between time spent on an area and your level of understanding?

3. Of the lessons and activities, which do you think were the most helpful and least helpful to you? Why?

PLANNING THE NEXT CYCLE

Complete the blank Study Cycle below, listing and committing to at least one activity for each step to help you with studying and learning new topics. The activities can be ones you already used or new ones. Be creative.



Summary and Outcomes

This week's activities centered on improving your capacity to think critically about a STEM topic and expanding your understanding of the process of learning. Moving forward the learning process will be critical to completing your weekly activities. As you embark on a new learning activity, ask yourself the following:

- Will the study cycle help me master this activity?
- If so, what steps of the study cycle will be most critical? Least?
- What are other methods I can use to help me with my work?

When you complete each activity, be sure to reflect on what worked for you and what did not. PREP values your feedback on this and will use it to improve our programming.

PREVIEW OF WEEK 2

Next week you will begin the STEM content-oriented activities for PREP Alternative. You are encouraged to review Week 1 materials prior to starting Week 2 and participate in any online programming or Q&A sessions if possible. Information on lessons and online sessions will be emailed and posted online. We wish you the best this summer and hope you enjoy program.

Air Blaster

Experiment with moving air by creating an air blaster!

You will need:

- An empty cardboard container (such as oatmeal, coffee, salt), without the lid, so one end is totally open.
- One or more large round balloons (12” or larger)
- Tape (duct tape, electrical tape or masking tape)
- Small sharp kitchen knife (for adults to use).

To build your blaster

1. On the solid end of the container, draw & cut out about a 1½ inch square or circle close to the center. Younger kids – ask an adult to do this part.)
2. Cut off about half of a 12-inch balloon, and throw out the end that had the opening. Stretch the remaining balloon over the fully open end of your container.
3. Wrap tape around the sides of the container where the balloon meets the container, to hold the balloon in place.

Test Your Blaster

1. Prepare your target: Stack up a few lightweight foam or paper cups.
2. Hold the can with one hand and aim the small hole toward your target. Smack or bang the balloon, or pinch and pull back the center of the balloon, then release it, to cause a rush of air to leave the blaster and knock the cup over or move the cups. This may take a little practice in aiming the blaster at just the right angle.

Try this:

- What is the greatest distance you can be from a target and still hit it with the air?
- How could you make a stronger air blaster?

- What if you try different sizes of containers?
- How about balloons that are stretched more or less taut?

What's going on?

The physics of moving air is called fluid dynamics. Air is a fluid just like liquids. Hitting, tapping, or stretching and releasing the rubber membrane forces a sudden gush of air out the opening. The surrounding air is disturbed forming an invisible swirling and twisting of air similar in shape to a doughnut. Such twisting of air is called a vortex. In fact, some science theater performers making these rings of air visible using dry ice or a fog machine.

Bubbles and Soap Film Experiments

While free-floating bubbles are spherical, soap films can take on many different shapes. It all depends on the bubble wand.

What you will need:

- Pipe cleaners (chenille sticks)
- Dish soap (Dawn or Joy works best)
- Plastic tub deep enough to submerge your wands
- Water
- Optional additives to soap solution:
  – Baking powder
  – Guar gum
  – Glycerin
- Optional items to blow bubbles through:
  – Individual serving size yogurt tubs and/or
  thin plastic drinking water bottles, with ends cut off
  – Plastic hair curlers

Caution: Prepare to get wet and soapy. Surrounding areas will be slippery!

Here's what to do:

To make your soap solution you can experiment with the soap type or concentration.
A typical mixture uses a dilution of about two tablespoons of soap per cup of water, or for a larger tub, use 1 part of dish soap to 3½ – 4 parts of water. After you've got your favorite concentration of soap and water working, as an additional experiment, you may want to try

adding very small amounts of baking powder, guar gum, or glycerin (start with less than a teaspoon).

To make soap film wands, experiment with pipe cleaners to create a variety of shapes. For simple bubble blowing, you can make flat, 2-D shapes on the end of the pipe cleaner, to blow bubbles through. Twist or braid a few pipe cleaners together to increase their strength when you dip them in the soap solution.

- Does the shape of the wand make a difference in the shape of the bubble formed? What happens when you try blowing through a tube, such as one of the optional items above? Does the length or width of the tube matter? What else could you blow bubbles through?
- What do you notice about the colors and the patterns of the bubbles or the soap films on the wands?
- Do they change over time?

Take it further:

You can also experiment with bending the pipe cleaners into three-dimensional shapes. To help form your shape, you can bend the pipe cleaner around a small tube or box. How many different shapes can you make?

Pipe cleaners make good bubbles because they hold a lot of liquid, but they drip a lot! You can try other materials for your bubble wands such as plastic or metal wires, canned beverage six-pack rings, yogurt lids cut into spirals and more! Explore this website for more ideas on geometrical wands.

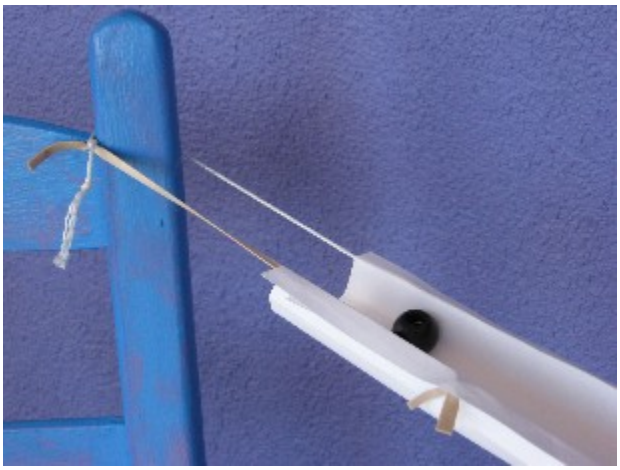
- What do you notice about about the shape of the wand, and the shapes formed by the soap films?
- Do the films rearrange into a new shape if you pop some of the sides?

From Here to There

How would you design and build a structure that can transfer a small ball between two points bridging a 6-foot gap?

What you will need:

- Small balls of various mass and size (marbles, Styrofoam balls, etc.)
- 5 sheets of paper
- 5 paper clips
- 5 rubber bands
- 10 feet of string or yarn
- 20 inches of tape (masking or painter's tape is best)
- 2 pieces of furniture separated by a 6-foot distance
- Scissors



Here's what to do:

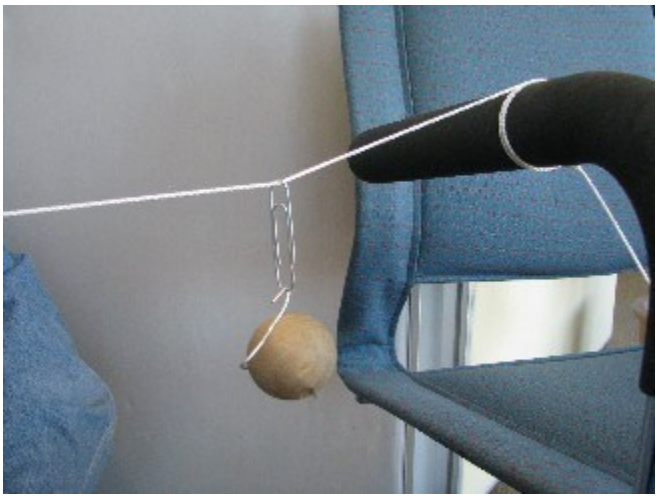
Well, it's totally up to you. Here are the engineering challenges:

1. you can use less but not more of the suggested materials
2. the ball cannot be thrown
3. once the ball is in motion, the set-up and the ball cannot be touched.

Take it further:

- How many different structural set-ups can you think of?

- How does your engineering strategy change if the two points are not level with each other?
- How does the size or mass of the ball affect how the ball travels between the two points?
- Can you increase the distance the ball travels using the limited materials?



Ice Melt Race

What material will make ice melt faster? Test different materials in your kitchen to find out.

You will need:

- Tray of ice cubes
- Metal frying or cooking pan
- Wooden or plastic cutting board
- Any other material you want to test, such as a glass, ceramic bowl, plastic plate, cast iron griddle, Styrofoam takeout container, aluminum foil, etc.
- You may want a towel, sponge, or napkins to wipe up.
  Note: When ice melts, you get… water! Consider the location and surface for your experiment.

Here's what to do:

1. Prepare your ice several hours or overnight before your experiment.

2. Feel the metal pan and cutting board with your hand. When you put your palm or fingers on it, does one of the surfaces feel warmer or colder than the other?
3. Make a prediction about which material will cause an ice cube to melt faster.
4. Take out two ice cubes. Place one on the pan and one on the cutting board at the same time.

- Is one melting faster than the other?
- Is it the one that you predicted would melt faster?

Choose other materials to test how quickly they melt the ice. Feel the material and predict if it will melt the ice quickly or slowly, then place ice cubes on them and see if the results match your predictions.

OPTIONAL: You might want to use a timer, to time your melting races, and make a chart for your predictions and results.

Do you notice a relationship between *how warm or cool each material feels to your hand* and *how quickly it melts the ice*

What's going on?

You've probably noticed that the frying pan feels colder than the cutting board. They are both at room temperature, but even though the pan feels colder, it actually makes the ice melt faster!

When you touch the pan, the heat of your hand quickly transfers out of your hand and into the pan. This leaves your hand feeling cold. But when you touch the cutting board, only a little heat slowly flows into the board. So your hand still feels warm. Remember both the pan and cutting board are at room temperature, much warmer than an ice cube! Heat from the room transfers quickly through the pan into the ice cube, melting it very quickly. But heat only slowly transfers to the ice cube on the cutting board, making it melt more slowly.

The difference happens because of a property called thermal conductivity. Thermal conductivity measures how quickly heat flows through a material. Materials like aluminum, stainless steel and copper (materials that pans are usually made of) have a high thermal conductivity, while materials like plastic and Styrofoam (materials that are often used in things like ice chests) have a low thermal conductivity.

Make a Bouncy Egg

Make a bouncy, see-through egg

Materials:

- Mason jar or other airtight container with lid
- White vinegar
- Egg

Safety Notes:
When handling raw egg shells or insides, wash your hands after handling – and avoid consuming raw eggs. And of course, broken eggs can get messy, so take this into consideration when you decide where to do your experiment!

Here's what to do:

1. Carefully, place the egg in the airtight container.
2. Add white vinegar to the container until the egg is completely covered. If the egg starts to float, that's okay, just fill the container.
3. Look for bubbles as the chemical reaction starts. Wait for the bubbles to slow down.
4. Secure the lid on the container to make it airtight.
5. Set your egg container in a cool place, and keep an eye on it for about a week. Be sure to wash your hands after handling the raw egg!
6. After a week, open the container, pour out the vinegar, and rinse your egg gently with water. Carefully, tip the container so the egg slides into your hand. Don't use a spoon or other utensil to scoop the egg out of the container as it will likely puncture the egg.
7. Gently, rub the rest of the eggshell off while running the egg under water.
8. Now, go outside or somewhere that can get messy (like the kitchen sink), and play with it! The eggshell should be gone and your egg should be swollen and bouncy!

9. When you're done playing, clean up any mess and wash your hands as raw eggs can carry salmonella. Your egg should not be consumed, just throw it away.

Take it further:

- Try gently bouncing your egg in the kitchen sink or on a sidewalk. How high does it bounce? How high can you drop it from without the egg popping when it hits the bottom?
- When you're done bouncing the egg, pop it! What does the inside feel like? Does the yolk feel the same as a yolk from a raw egg? How does it feel different?
- If you don't want to pop your egg, let it sit, open to air, until the water evaporates. Now, what does the egg look like? Feel like? Does it still bounce? How long did it take for the water to evaporate? If you don't want to wait, submerge your egg in corn syrup. What happens?
- Do an experiment: Make multiple eggs and use different amounts of vinegar (1 cup, 1.5 cups, etc.) Which shell dissolves first? Weigh your eggs before and after, which one took in the most water? Which is bounciest? Can you determine in which reactions your vinegar was the limiting reagent?
- Soak your egg is a cup of water for an extra day or two. How much water can you get the egg to absorb? How big can the egg get?

What's going on?

White vinegar is acetic acid, and the eggshell is mostly calcium carbonate. The acetic acid reacts with the calcium carbonate to form calcium acetate, carbon dioxide (the bubbles you see), and water, resulting in a dissolved eggshell.

$$\mathbf{CaCO_3\ (s) + 2\ HC_2H_3O_2\ (aq) \rightarrow Ca(C_2H_3O_2)_2\ (aq) + H_2O\ (l) + CO_2\ (g)}$$

Most household white vinegar is only 5% acetic acid with the other 95% being water. When one of the two reactants in the chemical equation is used up, the reaction stops because it's out of ingredients. In this reaction, the acetic acid is likely to be the limiting reagent, and that's why

some of the eggshell needs to be washed away – there wasn't enough acetic acid to completely dissolve the shell.

Another process happens at the same time and causes the egg to swell. The water in the vinegar crosses the egg's membrane by osmosis and stretches the membrane, making the egg bigger. The membrane holds the egg together even though there is no shell, but water can pass through because the membrane is semipermeable. Osmosis is the scientific term for this movement into and out of the membrane, and the goal is to make the amount of water on each side of the egg membrane equal. If you put your egg in corn syrup, the egg shrinks because the water is leaving; there is less water in the syrup than in the egg, so water has to leave the egg until the two sides have equal amounts. If you let your egg sit open to air for a few days, the semipermeable membrane allows the water to evaporate until your egg shrinks and you are left with the yolk in the membrane.