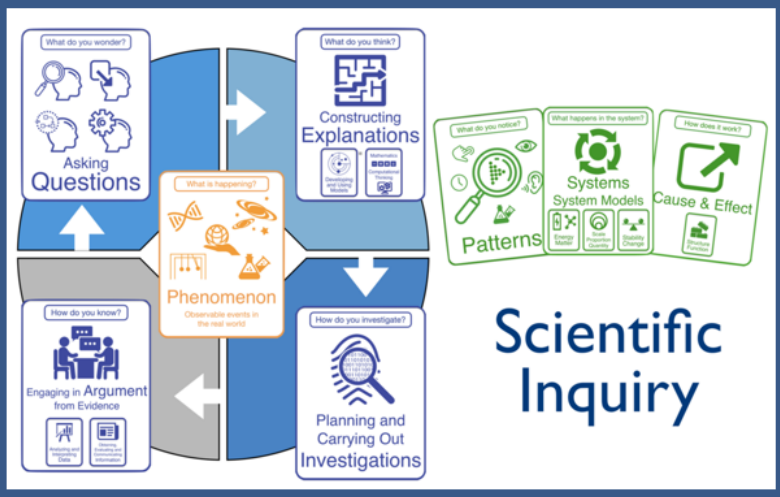
DETROIT PUBLIC SCHOOLS COMMUNITY DISTRICT

High School Science

Next Gen Inquiry Project

Students Rise. We All Rise.



DETROIT PUBLIC SCHOOLS COMMUNITY DISTRICT

High School Science

WEEKLY DISTANCE LEARNING STUDENT SCHEDULE

Distance Learning Plan Overview

The district is providing all high school students with a ***Next Gen Inquiry Project*** focused on the Crosscutting Concepts found in every science standard. The contents of the project have been organized into a 10-week learning plan. In the learning plan below, the contents of the Next Gen Inquiry Project have been mapped into10 phenomena (which students will investigate over the course of 10 weeks). Each week of the project includes an introduction to a phenomenon, along with a weekly note catcher, and scientific articles and links to support deeper learning about the phenomenon.

Pace of the lessons for the week:

- At the beginning of each week, students will have a new phenomenon to investigate. Students will use the weekly note catcher (included in the Inquiry packet) to document their thinking and learning throughout the week.
- Students will ask questions about the phenomena, investigate the scientific ideas behind the phenomena, draw models and revise them, and connect them to a Crosscutting Concept (CCC).
- By the end of each week, students will have completed their note catcher and one of the Crosscutting Concept graphic organizers (included in the Next Gen Inquiry Project packet).

*Parents can engage in the project with their students by asking them the **Discussion Questions** on the CCC pages. Students should be able to explain the phenomenon to their parents at that point in the lessons.

Packet Contents:

For **each week** you will find a new:

- Weekly Note Catcher
- Introduction to phenomena
- Scientific article and links for deeper learning

In the back of the packet you will find:

- Description of Crosscutting Concepts with links to videos
  - Discussion Questions
  - (If you have access to technology the videos are highly recommended)
- Crosscutting Concept Graphic Organizers (7)
  - There are only one of each provided. Students can copy the outline onto their own sheet if they choose to connect their weekly phenomena to a CCC more than once.
- Rubric and description for Student Models

https://www.detroitk12.org/

Week 1: Week of 4/14/20 to 4/17/20

Phenomena	Phenomena Video	Informational Video	Article
Killer T-Cells (Pg. 5)	Watch: Oldest Living Veteran	Watch: Killer T-Cell	Read: Cytoxic Cells

Week 2: Week of 4/20/20 to 4/24/20

Phenomena	Phenomena Video	Informational Video	Article
Stain Removal Pens (Pg. 9)	Watch: Stain Eraser Pen	Watch: Stain Removers	Read: Tide to Go Pens

Week 3: Week of 4/27/20 to 5/1/20

Phenomena	Phenomena Video	Informational Video	Article
Sweating (Pg. 13)	Watch: Sweat	Watch: Why Do We Sweat?	Read: Science of Sweat

https://www.detroitk12.org/

Week 4: Week of 5/4/20 to 5/8/20

Phenomena	Phenomena Video	Informational Video	Article
Turbulence (Pg. 19)	Watch: Plane Turbulence	Watch: Turbulence	Read: What is Turbulence?

Week 5: Week of 5/11/20 to 5/15/20

Phenomena	Phenomena Video	Informational Video	Article
The Cheerios Effect (Pg. 23)	Watch: Cheerios Commercial	Watch: The Cheerios Effect	Read: Cereal Science

Week 6: Week of 5/18/20 to 5/22/20

Phenomena	Phenomena Video	Informational Video	Article
Smog (Pg. 28)	Watch: Air Pollution in LA	Watch: Science of Smog	Read: Smog

Week 7: Week of 5/25/20 to 5/29/20

https://www.detroitk12.org/

Phenomena	Phenomena Video	Informational Video	Article
Wasp Queen (Pg. 33)	Watch: The Cruel fate That Awaits a Hornet Queen	Watch: Reign of a Wasp Queen	Read: Wasp Queen

Week 8: Week of 6/1/20 to 6/5/20

Phenomena	Phenomena Video	Informational Video	Article
Leaning Tower of Pisa (Pg. 37)	Watch: Leaning Tower of Pisa	Watch: Leaning Tower of Pisa	Read: Leaning Tower of Pisa

Week 9: Week of 6/8/20 to 6/12/20

Phenomena	Phenomena Video	Informational Video	Article
Claws vs Nails (Pg. 42)	Watch: Built-In Claws	Watch: Claws vs Nails	Read: Claws vs Nails

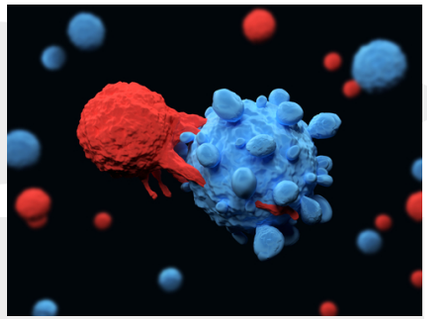
Week 10: Week of 6/15/20 to 6/19/20

Phenomena	Phenomena Video	Informational Video	Article
Neon Signs (Pg. 47)	Watch: Las Vegas Neon Lights	Watch: What Makes Neon Signs Glow?	Read: Neon Signs

https://www.detroitk12.org/

1 Week 1 Phenomena: Killer T-Cells

Read and/or watch the phenomena introduction



2 What questions do you have after first seeing the phenomena?

3 Draw an initial model to explain the phenomena.

4 Read and/or watch the videos to learn about the science behind the phenomena.

5 Revise your initial model or create a new model below with new information from readings and/or videos (See Model Rubric)

6 What additional questions do you have about this phenomena? Bonus: design an investigation to answer one of your questions (you may not be able to actually conduct this investigation at home).

7 Which Cross Cutting Concept will you learn more about this week? You should choose a new one each week.

Pick one of these CCCs:

- Systems and System Models
- Energy and Matter
- Structure and Function

8 Read and/or watch the provided videos to learn more about the Cross Cutting Concept (CCC) then complete the graphic organizer associated with that CCC. Use this week's phenomena to complete the graphic organizer.

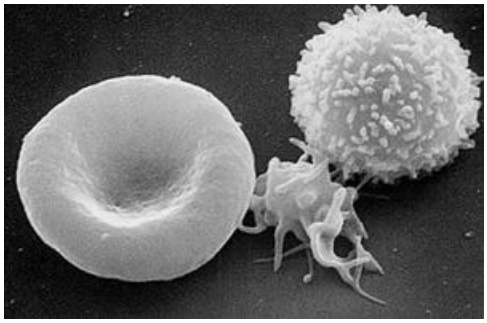
Cytotoxic T-Cells: Key to Longevity?

Phenomenon Description:

T-cells are a type of white blood cell that work with macrophages. Unlike macrophages that can attack any invading cell or virus, each T-cell can fight only one type of virus. You might think this means macrophages are stronger than T-cells, but they aren't. Instead, T-cells are like a special forces unit that fights only one kind of virus that might be attacking your body.

More than one kind of T-cell

There are two types of T-cells in your body: Helper T-cells and Killer T-cells. Killer T-cells do the work of destroying the infected cells. The Helper T-cells coordinate the attack.



Picture taken with a scanning electron microscope of a T-cell (right), platelet that helps blood to clot (center) and a red blood cell (left). The bumps on the T-cell are T-cell receptors used to fight infections. From The National Cancer Institute.

Killer T-Cells and Antigens

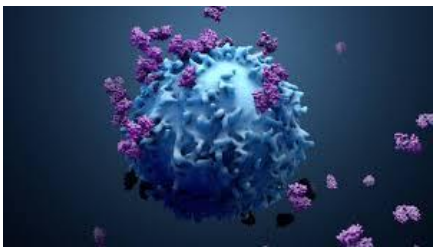
Killer T-cells find and destroy infected cells that have been turned into virus-making factories. To do this they need to tell the difference between the infected cells and healthy cells with the help of special molecules called antigens. Killer T-cells are able to find the cells with viruses and destroy them.

Antigens work like identification tags that give your immune system information about your cells and any intruders. Healthy cells have 'self-antigens' on the surface of their membranes. They let T-cells know that they are not intruders. If a cell is infected with a virus, it has pieces of virus antigens on its surface. This is a signal for the Killer T-cell that lets it know this is a cell that must be destroyed.

Source: https://askabiologist.asu.edu/t-cell

Phenomenon Video: Researchers at the University of Cambridge captured this dramatic footage of killer (cytotoxic) T cells capturing and destroying cancer cells. Take a look: https://thewonderofscience.com/phenomenon/2018/7/9/killer-t-cell-the-cancer-assassin

Could cytotoxic T-cells be a key to longevity?



Scientists from the RIKEN Center for Integrative Medical Science (IMS) and Keio University School of Medicine in Japan have used single-cell RNA analysis to find that supercentenarians -- meaning people over the age of 110 -- have an excess of a type of immune cell called cytotoxic CD4 T-cells. Supercentenarians are somewhat of a unique group of people. First, they are extremely rare. For example, in Japan in 2015 there were more than 61,000 people over the age of 100, but just 146 over the age of 110. And studies have found that these individuals were relatively immune to illnesses such as infections and cancer during their whole lifetimes. This led to the idea that it might be that they have a particularly strong immune system, and the researchers set out to find out what might explain this.

To answer the question, they looked at circulating immune cells from a group of supercentenarians and younger controls. They acquired a total of 41,208 cells from seven supercentenarians (an average of 5,887 per subject) and 19,994 cells for controls (an average of 3,999 per subject) from five controls aged in their fifties to eighties. They found that while the number of B-cells was lower in the supercentenarians, the number of T-cells was approximately the same, and in particular, the number of one subset of T-cells was increased in the supercentenarians. Analyzing these cells, the authors found that the supercentenarians had a very high level of cells that are cytotoxic, meaning that they can kill other cells, sometimes amounting to 80 percent of all T-cells, compared to just 10 or 20 percent in the controls.

Normally, T-cells with markers known as CD8 are cytotoxic, and those with the CD4 marker are not, so the authors first thought that perhaps CD8-positive cells were increased. But that turned out to not be the case. Rather, it seems that the CD4-positive cells of the supercentenarians had acquired cytotoxic status. Intriguingly, when the researchers looked at the blood of young donors, there were relatively few CD4-positive cytotoxic cells, indicating that this was not a marker of youth but rather a special characteristic of the supercentenarians. To look at how these special cells were produced, the team examined the blood cells of two supercentenarians in detail, and found that they had arisen from a process of clonal expansion, meaning that many of the cells were the progeny of a single ancestor cell.

According to Kosuke Hashimoto of IMS, the first author of the paper, "We were especially interested in studying this group of people, because we consider them to be a good model of healthy aging, and this is important in societies like Japan where aging is proceeding rapidly."

IMS Deputy Director Piero Carninci, one of the leaders of the groups, says, "This research shows how single-cell transcription analysis can help us to understand how individuals are more or less susceptible to diseases. CD4-positive cells generally work by generating cytokines, while CD8-positive cells are cytotoxic, and it may be that the combination of these two features allows these individuals to be especially healthy. We believe that this type of cells, which are relatively uncommon in most individuals, even young, are useful for fighting against established tumors, and could be important for immunosurveillance. This is exciting as it has given us new insights into how people who live very long lives are able to protect themselves from conditions such as infections and cancer."

The research, published in *Proceedings of the National Academy of Sciences (PNAS)*, was performed by a collaboration including scientists from the RIKEN Center for Integrative Medical Sciences and Keio University School of Medicine.

Source: https://www.sciencedaily.com/releases/2019/11/191113101845.htm

READ THIS

1 Week 2 Phenomena: Stain Eraser

Read and/or watch the phenomena introduction

2 What questions do you have after first seeing the phenomena?

3 Draw an initial model to explain the phenomena.

4 Read and/or watch the videos to learn about the science behind the phenomena.

5 Revise your initial model or create a new model below with new information from readings and/or videos (See Model Rubric)

6 What additional questions do you have about this phenomena? Bonus: design an investigation to answer one of your questions (you may not be able to actually conduct this investigation at home).

7 Which Cross Cutting Concept will you learn more about this week? You should choose a new one each week.

Pick one of these CCCs:

- Structure and Function
- Patterns
- Cause and Effect

8 Read and/or watch the provided videos to learn more about the Cross Cutting Concept (CCC) then complete the graphic organizer associated with that CCC. Use this week's phenomena to complete the graphic organizer.

Oops! Did I Do That??

Phenomena description:

If you have ever experienced getting dressed up to go to an important event only to spill sauce down the front of a shirt or to find a grease stain on your favorite pair of pants. Well, you'll definitely appreciate the ease of using a stain eraser pen!

Phenomena video:
Watch this video to see how a stain eraser pen works
https://www.youtube.com/watch?v=yjpfy974Rf8

How to use a stain eraser pen:
Tide to Go is one of the common stain eraser pens on the market. It comes in a small, pen-like container with a cap so you can carry it in your pocket or purse for common stain emergencies. It is sold in single packs, three-packs, and five-packs. Here are the basic steps for removing stains:

1. Remove excess food from the clothing, using a napkin, tissue, or clean cloth. Be careful not to spread the stain.
2. Press the tip of the Tide to Go pen onto the stain several times to release the stain remover.
3. Rub the tip of the Tide to Go pen across the stain to remove it. Add more stain remover as needed.
4. Wipe excess solution off the stained area if the fabric will be exposed to sunlight

Clean IQ: What's Really in Those Tide to Go Pens? And Why Don't You Have to Rinse Them?
BY MEGHAN NESMITH PUBLISHED: MAY 6, 2019

What Is It?
The Tide to Go Instant Stain Remover pen is a portable, detergent-based, highlighter-like stain removing stick that lifts and "erases" common stains without the need for washing or rinsing.

The Ingredients and Science Behind Tide to Go
The magic of the Tide to Go pen lies in its portability, its jaunty, go-anywhere attitude. If you were, say, taking tea with Meghan Markle and splooshed some jam out of your crumpet and onto your white fascinator, you could discretely excuse yourself to take care of your royal mishap. Stain removing pens are often a far better solution than soap and water—depending on the temperature of the water and the makeup of the fabric, you might cause the stain to run or set (and unless you have a backup fascinator hiding in the glovebox of your Aston Martin, you're SOL).

According to Jennifer Ahoni, Procter & Gamble's Scientific Communications Manager for Fabric Care, the Tide to Go pen was developed especially for these on-the-go stains: the particular combination of detergents and surfactants were chosen specifically to work without rinsing.

"The key ingredient is hydrogen peroxide," says Ahoni. "It breaks down the molecular structure of the pigments in the food, making the color and stain essentially disappear." Basically, hydrogen peroxide attacks color-causing chemicals (also known as chromophores), and, by dissolving them, makes the stain appear to vanish.

If you're wondering (like I am) why the hydrogen peroxide only reacts with the fresh stain and doesn't, say, bleach your clothes to bits, the principle is the same as any laundry detergent: Garments are dyed and treated so as to be fairly color-fast, and the hydrogen peroxide in stain removal pens is gentle enough not to interact with the colors of your clothing. (For the record, Tide does suggest testing the pen on an inside seam if you're concerned about colorfastness.)

Other important ingredients in your stain sword include various surfactants and detergents that grip stain molecules to help pull them from the fabric; and, crucially, water, which activates the surfactants and helps them swoosh off stains. Finally, magnesium sulfate—a.k.a. Epsom salt—helps the spot dry quickly enough for you to get back to your tea.

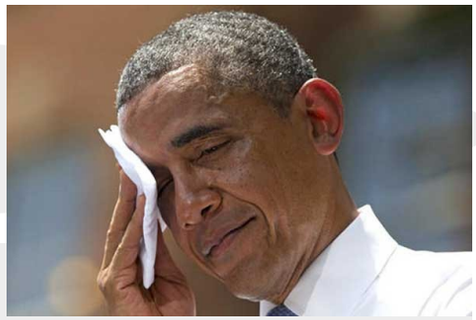
The Best Way to Use Tide to Go Pens
According to Tide, 72 percent of stains that people experience on the go are the result of food and drink, and that's what the pen was designed to attack. It works best on stains like ketchup, coffee, and wine; less so on protein stains like blood or grass. (Here's a helpful stain removal chart that breaks down the molecular structures of particular stains, if you're into that kinda thing.) Additionally, Ahoni recommends first wiping the stain gently to remove any excess, and attacking the stain immediately. Once a stain is dry, you're better off treating it when you get home with a more traditional, heavy-hitting stain remover before tossing it in the wash, or handing it to your long-suffering partner with a meek shrug.

Source: https://www.apartmenttherapy.com/tide-to-go-how-to-use-268453

READ THIS

1 Week 3 Phenomena: Sweating

Read and/or watch the phenomena introduction



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7 Which Cross Cutting Concept will you learn more about this week? You should choose a new one each week.

Pick one of these CCCs:

- Scale, Proportion, and Quantity
- Energy and Matter
- Stability and Change

8 Read and/or watch the provided videos to learn more about the Cross Cutting Concept (CCC) then complete the graphic organizer associated with that CCC. Use this week's phenomena to complete the graphic organizer.

Sweating

Phenomenon Description:

Sweat is mostly water and salt, with small amounts of other substances, including minerals and electrolytes.

If you believe a good sweat can also rid your body of toxins (possibly stockpiled because of a stressful fight with your mother or a too-late night out with the girls), it's unfortunate to have to report that that's not the case. Detoxing is the liver's job.

You have between 2 million and 4 million sweat glands spread over your entire body. While armpits have one of the highest concentrations, the glands are actually everywhere.

Two types of sweat glands are involved in perspiring. Eccrine glands, which respond to heat, are located just about everywhere on your body; they release an essentially odorless sweat directly onto your skin to cool your body. Apocrine glands develop in your hair follicles — on your scalp and in your armpits, for example — and they respond to heightened emotions as well as to heat. They release a fatty sweat that's broken down by bacteria on the skin, in a process that produces a stink.

Sources:

https://www.everydayhealth.com/news/the-science-of-sweat/

Phenomenon Video:

There are a number of scenarios that can make us sweat–including exercise, eating spicy foods, and nervousness. But how does this substance suddenly materialize, and what exactly is its purpose? Take a look:

Sweat

Keeping Cool: The Science of Sweat

A person has 2 million to 4 million sweat glands.
(Image: © Pimonpim w/Shutterstock)

While sweating, or perspiration, can be embarrassing, it is an important body function. Sweating, and a lack of sweating, can also be a helpful sign that there is something wrong with the body.

Causes

Sweating is the release of a salty liquid from the sweat glands. The liquid has one main purpose: as it evaporates, it helps to cool the body. Sweating is regulated by the autonomic, or sympathetic, nervous system. Signals, using the neurotransmitter acetylcholine, are sent to the sweat glands. The sweat is then released to the skin surface through ducts.

A person has 2 million to 4 million sweat glands, with the highest density of sweat glands on the palms of hands and soles of feet, according to the National Library of Medicine.

"From baby to adult, the number of sweat glands does not change. Therefore, babies have the highest number of sweat glands per square inch, i.e. 8 to 10-fold higher than adults," said Dr. Eugene Bauer, chief medical officer at Dermira and former dean of Stanford University's School of Medicine.

Sweat is odorless. Bacteria on the skin mixing with sweat is what produces body odor. Most sweat is colorless, too. Both odor and sweat stains are caused by the apocrine sweat glands.

"Yellow underarm stains are caused by your apocrine glands, which contain proteins and fatty acids and thus make underarm secretions thick and milky," said Dr. Niket Sonpal of Touro College of Osteopathic Medicine in New York.

The secretions also attract bacteria from the skin, which breaks down the secretion and creates the bad smell.

What's Normal

It's not unusual for some people to only perspire a little and for others to sweat a lot. "The normal range for sweating is very wide," said Dr. Robert Sallis, co-director of the sports medicine fellowship at Kaiser Permanente Fontana Medical Center. "Some people might only sweat half a liter during an hour of intensive activity, while some might sweat 3 or 4 liters, and both are still within a normal range."

A person's size and gender can play a role in how they sweat and where they sweat. People who are out of shape, for example, tend to sweat in a central pattern, such as at the center of their chest or back. Those who are more in shape tend to sweat more evenly across their body. Also, women typically sweat less than men. "People used to think women were more likely to suffer heat stroke and therefore incapable of running marathons,"

explained Sallis. "The truth is, women have fewer sweat glands, but they also have less muscle mass so they produce less heat (and therefore need to sweat less)."

Sweat loss vs. water intake

A person's sweat rate is the amount of sweat lost during an activity. To prevent dehydration, marathoners, triathletes and other athletes find their sweat rate so they know how much water they need to drink during an activity.

Here is how to measure someone's sweat rate:

1. Weigh the body, nude, on a set of scales.
2. Do an intensive physical activity for an hour, like running, ideally in the condition in which they will compete (hills, humidity, etc.).
3. Weigh while nude again.

The amount of weight lost is the sweat rate. One pound (0.45 kilograms) of weight loss equals 16 ounces (0.47 liters) of sweat loss. "This rate can vary somewhat based on the intensity of the activity, humidity, blood sugar rate and other factors," said Sallis. "Once this rate is established, it should be used as the amount of water the athlete needs to drink in that hour of activity, incrementally."

Problems

Lack of sweat when a person is hot could be a symptom of many medical disorders. "There are a couple of things that come to mind when I hear that someone is hot, but not sweating," Dr. Neha Pathak, WebMD's medical editor, told Live Science. "The most concerning, depending on the rest of the story, is heat stroke."

Heat stroke happens after prolonged exposure to high temperatures, explained Pathak. For younger people, it generally occurs after prolonged exercise or outdoor activity, without adequate hydration. For older people, it can happen without exertion because of underlying medical conditions, medications or other factors like physical disability. Hot and humid weather makes cooling off through sweat evaporation ineffective. The longer the exposure, the more dehydrated a person becomes. This can eventually lead to a body temperature above 104 F (40 C), along with feeling faint, dizzy, nauseous, and confused. "You can feel very hot without any sweating. Without treatment, there can be serious complications from heat stroke," said Pathak.

There are many other reasons why someone may not sweat. For instance, there could be nerve damage. Conditions that can lead to this type of nerve damage include diabetes, alcoholism, Parkinson's disease or direct damage to the skin, such as after trauma, said Bauer.

Sometimes skin diseases, such as psoriasis or heat rash, can interfere with normal sweat gland functioning, as well. Conditions called hypohidrotic ectodermal dysplasia and hypohidrosis, also known as anhidrosis, can also cause the sweat glands to malfunction.

Menopause can lead to the sensation of feeling hot or having episodes of "hot flashes" without associated sweating, as well, said Pathak.

A person who is not hot, but is still sweating, may have a problem with their sympathetic nervous system. "Many times, this excessive sweating is associated with stimuli, e.g. eating spicy foods or nervousness, but often there is no specific reason why this happens," said Bauer.

Hyperhidrosis is a skin condition where the body sweats more than what is required to keep cool because of overactive sweat glands. It can affect the underarms (axillary hyperhidrosis), palms of the hands, soles of the feet and face, according to the Mayo Clinic.

If the heavy sweating is accompanied by chest pain, lightheadedness, chills, nausea or a body temperature of 104 F (40 C) or higher, seek immediate medical assistance.

Additional facts

"Researchers are looking into harvesting energy from human sweat," said Pathak. "They have shown that they can use the electrochemical properties of sweat to power wearable biomedical devices, like heart rate and blood pressure monitors. These techniques are being used to develop power sources for wearable electronic devices. Their work shows that human sweat can be used as a biofuel!"

Source: https://www.livescience.com/59254-facts-about-sweating.html

READ THIS

1 Week 4 Phenomena: Turbulence

Read and/or watch the phenomena introduction

2 What questions do you have after first seeing the phenomena?

3 Draw an initial model to explain the phenomena.

4 Read and/or watch the videos to learn about the science behind the phenomena.

5 Revise your initial model or create a new model below with new information from readings and/or videos (See Model Rubric)

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- Cause and Effect
- System and System Models
- Structure and Function

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Turbulence: One of the Great Unsolved Mysteries of Physics

Phenomenon Description:

Turbulence — called "clear-air turbulence" when it occurs in otherwise calm, blue skies — is caused when a mass of air moving at a particular speed meets another mass of air that's moving at a different speed. It's often created by jet streams, thunderstorms, weather fronts and air moving around mountains, according to the Federal Aviation Administration (FAA).

Physicists describe turbulence as "turbulent flow," or the movement of a gas or liquid in which the fluid undergoes irregular mixing, causing changes in the fluid's speed, pressure and direction. ("Laminar flow," in contrast, is a fluid movement with constant speed, direction and pressure.)

Pockets of turbulent air can be difficult for forecasters to predict, and pilots often rely on turbulence reports from other pilots who have recently flown a certain flight path. Other clues that there might be turbulence in an area include the presence of cumulonimbus clouds, mountain ranges, and cold or warm fronts.

Source: https://www.livescience.com/43448-air-turbulence-dangerous-injuries.html

Phenomenon Video:

If you've ever flown before, you've probably experienced turbulence before. But what is turbulence exactly, and why does it happen? Watch this video on turbulence to answer those questions.

Plane Turbulence

What is turbulence—and how can you calm down about it?

EVERYONE HAS A story about hitting a rough patch of air, those hair-raising moments when suddenly more than the plane is flying. Bellies drop, drinks slop, and people caught in the aisle lurch against seats. In rare cases, it can even mean more than bumps or bruises.
In air travel, turbulence is a certainty and a major source of flight anxiety for flyers of all stripes. But understanding what causes turbulence, where it occurs, and the high-tech tools pilots use to make air travel safer and more comfortable may help settle even the most anxious flyer's nerves.

What is turbulence?
The definition of turbulence is fairly straightforward: chaotic and capricious eddies of air, disturbed from a calmer state by various forces. If you've ever watched a placid thread of rising smoke break up into ever more disorganized swirls, you've witnessed turbulence.

Rough air happens everywhere, from ground level to far above cruising altitude. But the most common turbulence experienced by flyers has three common causes: mountains, jet streams, and storms.

Just as ocean waves break on a beach, air also forms waves as it encounters mountains. While some air passes smoothly over and onward, some air masses crowd against the mountains themselves, left with nowhere to go but up. These "mountain waves" can propagate as wide, gentle oscillations into the atmosphere, but they can also break up into many tumultuous currents, which we experience as turbulence.

Disorderly air associated with jet streams—the narrow, meandering bands of swift winds located near the poles—is caused by differences in wind velocities as an aircraft moves away from regions of maximum wind speeds. The decelerating winds create shear regions that are prone to turbulence.

And though it's easy to understand turbulence created by thunderstorms, a relatively new discovery by researchers is that storms can generate bumpy conditions in faraway skies. The rapid growth of storm clouds pushes air away, generating waves in the atmosphere that can break up into turbulence hundreds to even thousands of miles away, says Robert Sharman, a turbulence researcher at the National Center for Atmospheric Research (NCAR).

Each of these scenarios can cause "clear air turbulence," or CAT, the least predictable or observable type of disturbance. CAT is often the culprit behind moderate to severe injuries, as it can occur so suddenly that flight crew don't have time to instruct passengers to buckle up. According to the Federal Aviation Administration, 524 passengers and crew were reported injured by turbulence between 2002 and 2017.

Prediction improvements
Though weather forecasts and pilot reports are helpful for avoiding bumpy zones, they are relatively blunt tools, Sharman says. Weather models can't predict turbulence at airplane-sized scales, and pilots frequently misreport turbulent locations by many dozens of miles. At NCAR, Sharman has been working since 2005 to build much more precise "nowcasting" turbulence tools.

Source: https://www.nationalgeographic.com/travel/features/what-is-turbulence-explained/#close

READ THIS

1 Week 5 Phenomena: The Cheerio Effect

Read and/or watch the phenomena introduction

2 What questions do you have after first seeing the phenomena?

3 Draw an initial model to explain the phenomena.

4 Read and/or watch the videos to learn about the science behind the phenomena.

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6 What additional questions do you have about this phenomena? Bonus: design an investigation to answer one of your questions (you may not be able to actually conduct this investigation at home).

7 Which Cross Cutting Concept will you learn more about this week? You should choose a new one each week.

Pick one of these CCCs:

- Patterns
- Scale, Proportion, and Quantity
- Stability and Change

8 Read and/or watch the provided videos to learn more about the Cross Cutting Concept (CCC) then complete the graphic organizer associated with that CCC. Use this week's phenomena to complete the graphic organizer.

The Cheerio Effect: Why Do Breakfast Cereals Clump Together?

Phenomenon Description:

It's almost impossible to count the number of physical phenomena taking place right in front of your eyes in every passing moment. From the second you wake up in the morning to the time you finally close your eyes to go to sleep, you're continually witnessing a host of physical phenomena without even realizing it.

For instance, consider this: have you ever wondered why breakfast cereals tend to stick together or cling to the sides of the bowl?

Buoyancy and Surface Tension

To state it plainly: Put a ship in an ocean and it will float; fling a nail in the same ocean and… well, say goodbye to your nail.

Whether an object floats or sinks depends on a physical property referred to as buoyancy. If the object in question is denser than the liquid surrounding it, then it will sink; however, if it's less dense, then it will float. It's as simple as that!

Surface tension is another important concept related to liquids. It makes liquids act like 'flexible membranes'. Surface tension is caused due to weak forces between the molecules of the liquid. The water molecules at the surface of a liquid experience 'pulling' forces from different directions; the air molecules above pull them upwards, while the neighboring water molecules pull them in every other direction! Depending on which of these forces is stronger, the surface of the liquid caves in that direction, giving rise to a 'meniscus'.

The Meniscus Effect

As mentioned above, the forces between the water molecules and air molecules slightly alter the surface of the liquid in a container. The resulting curve on the surface due to these unequal forces is called a meniscus. A meniscus can come in two types: upward (convex) and downward (concave). The type that is formed depends on the properties of the liquid in question.

Water, the most common liquid in our daily lives, forms a concave (or downward) meniscus, whereas mercury forms a convex meniscus.

Source: https://www.scienceabc.com/pure-sciences/the-cheerios-effect-why-do-breakfast-cereals-clump-together.html

Phenomenon Video:

Cheerios Commercial

Cereal Science: Why Floating Objects Stick Together

You may or may not have pondered why your breakfast cereal tends to clump together or cling to the sides of a bowl of milk. Now there is an easy explanation.

Dubbed the Cheerio Effect by scientists, this clumping phenomenon applies to anything that floats, including fizzy soda bubbles and hair particles in water after a morning shave.

The effect has been known for some time, but an explanation for non-scientists has been lacking.

Dominic Vella, a graduate student now at Cambridge University and L. Mahadevan, a mathematician from Harvard University, decided to change that. In a study that appears in the Sept. 15 issue of the *American Journal of Physics*, Mahadevan explains the Cheerio Effect using three basic concepts from physics: buoyancy, surface tension and the meniscus effect.

Simple physics

Buoyancy determines whether an object submerged in water or surrounded by air will sink, float, or stay put. Buoyancy is what keeps ships afloat and balloons afloat. If an object is less dense than the water or air surrounding it, the object floats; if the object is denser, it sinks.

Surface tension is a property that makes the surface of a liquid act like a flexible membrane. It results from various weak forces acting between liquid molecules.

In a glass of water, most of the water molecules are surrounded by other water molecules and they all pull on one another. But like two equally matched opponents in a game of tug-of-war, the net effect is zero and nothing really happens.

Where it gets interesting is at the surface, where water meets air, and along the sides of the glass.

Water molecules at the surface experience a strong inward pull from water molecules beneath them but only a weak outward pull from the air molecules above. So the surface of the water caves in slightly.

On the edge

Water near the side of a glass behaves differently. It curves to form what scientists call a "meniscus." Depending on the properties of the liquid, whether it is attracted to or repelled by the glass, the meniscus either curves upward (concave) or downward (convex).

For water, the meniscus is concave since water is attracted to the glass. Viewed from the side, the surface of the water looks like a less exaggerated version of a skater's U-shaped halfpipe.

What's all this do to your breakfast?

Place a single Cheerio in a bowl of milk and its weight will cause the milk beneath it to dip slightly, forming a dent in the once smooth surface of the milk. A second Cheerio placed into the bowl will form its own dent on the surface of the milk, and if the two Cheerios drift close enough to each other, they will appear to "fall into" one another, as if pulled together by an attractive force.

Cheerios near the edge of the bowl float upwards along the curve of the meniscus to look like they're clinging the edge of the bowl.

In both cases, the movements of the Cheerios are determined more by the geometry of the surface of the milk than by any attractive force acting between them.

The same principles also apply to denser objects. A tack can appear to float on water because its weight is counteracted by the surface tension of the water. (Unlike the Cheerio, however, the tack is not really floating. If pushed downward, it would sink.) Place another tack on the water and the two tacks will likewise appear to fall into each other if they drift close enough to one another.

Childlike wonder

Mahadevan is known for studying natural phenomenon that most people take for granted. Combining scientific rigor with a childlike wonder, he has studied the patterns made by crumpled paper, the way fabrics fold and wrinkle, how a flag flutters in a gentle breeze and the lightning-quick reflexes of the Venus flytrap.

"Familiarity does not mean comprehension," Mahadevan told *LiveScience*. "The world around you is robust. I don't have to go into a laboratory to do these kinds of fancy experiments; it just happens in front of your face, so I think it behooves us to actually explain that."

Apart from the sheer satisfaction gained from figuring something out, some of Mahadevan's studies also have practical applications.

The crumpled paper study is helping scientists understand how mountain ranges form and the cloth studies have helped animators and Internet sales departments create more natural looking clothing. The fly study could have applications for the glue industry.

A better understanding of the Cheerio Effect could give scientists a clearer insight into how certain insects walk on water and could lead to the creation of micro-structures that use surface tension to assemble themselves.

Sources:

https://www.livescience.com/9350-cereal-science-floating-objects-stick.html

http://people.maths.ox.ac.uk/vella/Vella2005.pdf

READ THIS

1 Week 6 Phenomena: Smog

Read and/or watch the phenomena introduction

2 What questions do you have after first seeing the phenomena?

3 Draw an initial model to explain the phenomena.

4 Read and/or watch the videos to learn about the science behind the phenomena.

5 Revise your initial model or create a new model below with new information from readings and/or videos (See Model Rubric)

6 What additional questions do you have about this phenomena? Bonus: design an investigation to answer one of your questions (you may not be able to actually conduct this investigation at home).

7 Which Cross Cutting Concept will you learn more about this week? You should choose a new one each week.

Pick one of these CCCs:

- Cause and Effect
- Stability and Change
- Systems and System Models

8 Read and/or watch the provided videos to learn more about the Cross Cutting Concept (CCC) then complete the graphic organizer associated with that CCC. Use this week's phenomena to complete the graphic organizer.

The Science of Smog

Phenomena description:

On July 26, 1943, Los Angeles was blanketed by a thick gas that stung people's eyes and blocked out the sun. Panicked residents believed their city had been attacked using chemical warfare. But the cloud wasn't an act of war. It was smog!

So what is this thick gray haze actually made of?
And why does it affect some cities and not others?
Is smog an issue in the city where you live? What exactly is it like to live in an area prone to long time periods where citizens are exposed to smog? Reflect on these questions as you learn about the science behind smog.

Phenomena video:

Watch this video that details the phenomena of smog.
https://www.youtube.com/watch?v=dcvvJcy1lkU

Smog

Smog is air pollution that reduces visibility. The term "smog" was first used in the early 1900s to describe a mix of smoke and fog. The smoke usually came from burning coal. Smog was common in industrial areas, and remains a familiar sight in cities today.

Today, most of the smog we see is photochemical smog. Photochemical smog is produced when sunlight reacts with nitrogen oxides and at least one volatile organic compound (VOC) in the atmosphere. Nitrogen oxides come from car exhaust, coal power plants, and factory emissions. VOCs are released from gasoline, paints, and many cleaning solvents. When sunlight hits these chemicals, they form airborne particles and ground-level ozone—or smog.

Ozone can be helpful or harmful. The ozone layer high up in the atmosphere protects us from the sun's dangerous ultraviolet radiation. But when ozone is close to the ground, it is bad for human health. Ozone can damage lung tissue, and it is especially dangerous to people with respiratory illnesses like asthma. Ozone can also cause itchy, burning eyes.

Smog is unhealthy to humans and animals, and it can kill plants. Smog is also ugly. It makes the sky brown or gray. Smog is common in big cities with a lot of industry and traffic. Cities located in basins surrounded by mountains may have smog problems because the smog is trapped in the valley and cannot be carried away by wind. Los Angeles, California, and Mexico City, Mexico, both have high smog levels partly because of this kind of landscape.

Many countries, including the United States, have created laws to reduce smog. Some laws include restrictions on what chemicals a factory can release into the atmosphere, or when the factory can release them. Some communities have "burn days" when residents can burn waste such as leaves in their yard. These limits on chemicals released into the air reduce the amount of smog.

Smog is still a problem in many places. Everyone can do their part to reduce smog by changing a few behaviors, such as:

- Drive less. Walk, bike, carpool, and use public transportation whenever possible.
- Take care of cars. Getting regular tune-ups, changing oil on schedule, and inflating tires to the proper level can improve gas mileage and reduce emissions.
- Fuel up during the cooler hours of the day—night or early morning. This prevents gas fumes from heating up and producing ozone.

- Avoid products that release high levels of VOCs. For example, use low-VOC paints.
- Avoid gas-powered yard equipment, like lawn mowers. Use electric appliances instead.

Source: https://www.nationalgeographic.org/encyclopedia/smog/

READ THIS

1 Week 7 Phenomena: The Wasp Queen

Read and/or watch the phenomena introduction

2 What questions do you have after first seeing the phenomena?

3 Draw an initial model to explain the phenomena.

4 Read and/or watch the videos to learn about the science behind the phenomena.

5 Revise your initial model or create a new model below with new information from readings and/or videos (See Model Rubric)

6 What additional questions do you have about this phenomena? Bonus: design an investigation to answer one of your questions (you may not be able to actually conduct this investigation at home).

7 Which Cross Cutting Concept will you learn more about this week? You should choose a new one each week.

Pick one of these CCCs:

- Cause and Effect
- Scale, Proportion, and Quantity
- Stability and Change

8 Read and/or watch the provided videos to learn more about the Cross Cutting Concept (CCC) then complete the graphic organizer associated with that CCC. Use this week's phenomena to complete the graphic organizer.

The Wasp Queen

Phenomenon Description:

The queen wasp is essentially the leader of the nest, and her main role is to lay eggs. She has bright yellow and black stripes, with a triangle-shaped head, a distinctive 'waist' and a sharp pointy sting.

Emerging from hibernation during the spring, the queen chooses a suitable area to build her nest, such as a hollow tree or in the cavity of a building. She then begins the process of constructing her nest using 'paper' which she creates by chewing up wood.

As each cell of the nest is carefully built, the queen lays an egg in it. After about a month the eggs hatch into sterile female adult workers, who take over the building and foraging, while the queen continues to lay eggs for the rest of her life.

Larvae then hatch and are fed by the adult workers. They eventually develop into fertile males, known as drones, and fertile females. The fertile females will become next year's queens. Both the fertile males and females then leave the colony to mate and find somewhere to hibernate.

As the temperature falls through winter, the current queen and the adult workers die, and the nest is left empty. The hibernating queens will ensure the continuation of the life cycle when they awake in spring.

Source: https://www.woodlandtrust.org.uk/blog/2019/02/how-big-is-a-queen-wasp/

Phenomenon Video:

The Cruel fate That Awaits a Hornet Queen

How Does a Wasp Become Queen?

For wasps, the path to royalty starts at birth.

In some wasp species, such as yellow jackets, the queen actually looks different from her worker siblings. She's about 0.25 inches (0.64 centimeters) longer than the worker wasps and is raised in a different part of the nest. (In all species of wasps, the queen reproduces while the workers take care of the family business, gathering food and tending to the hive.)

This difference in size between queens and workers is the norm for most advanced social insects, including ants and honeybees.

But for one type of wasp, paper wasps, all individuals in the community look alike at birth. The traditional way to tell the social status of a paper wasp is based in part on the reproductive state of the wasp larvae workers are born with their reproductive genes turned off, while queens had their genes turned on. New research, however, has turned this paradigm on its head.

The sterile workers/reproductive queens paradigm that has dominated the discipline is incorrect, said James Hunt, visiting professor at North Carolina State University and the lead study researcher. Instead, workers are born ready to reproduce while potential queens are born with their baby-making parts in the off mode.

This is wonderfully counter-intuitive, and it sets the foundation for why workers work, Hunt said. Workers' work is maternal care, which requires activated reproductive physiology in every way but two: Workers don't lay the eggs, and they care for offspring [that are] not their own.

The study researchers selected two sets of female larvae workers and potential queens and measured the expression level of certain genes known to be associated with reproductive states in other insect species. The results showed genes for reproducing were expressed at higher levels in the worker wasps than in the queens, while those related to a delay in fertility (for example, temporary sterility) showed up more in queens than workers.

Of course, these gene expression patterns must change the next season so that the queen can reproduce. The researchers found that the potential queens had higher levels of a group of proteins that help them survive the winter season so they can reproduce the following year.

The results, detailed in the May 17 issue of the journal PLoS ONE, have broader implications beyond their help in understanding the paper wasp caste system, Hunt said.

Scientists previously believed not only that worker wasps have their reproductive systems turned off, but that they chose to become workers out of altruism. The concept of altruistic behavior in species other than mammals was popularized by Edward O. Wilson father of biodiversity in the 1970s.

Our work can be interpreted as showing that the workers are not altruistic, Hunt told Life's Little Mysteries, pointing out that this is his own interpretation and not necessarily that of his research colleagues.

Source: https://www.livescience.com/32703-how-does-a-wasp-become-queen-.html

READ THIS

1 Week 8 Phenomena: Leaning Tower of Pisa

Read and/or watch the phenomena introduction

2 What questions do you have after first seeing the phenomena?

3 Draw an initial model to explain the phenomena.

4 Read and/or watch the videos to learn about the science behind the phenomena.

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7 Which Cross Cutting Concept will you learn more about this week? You should choose a new one each week.

Pick one of these CCCs:

- Structure and Function
- Cause and Effect
- Scale, Proportion, and Quantity

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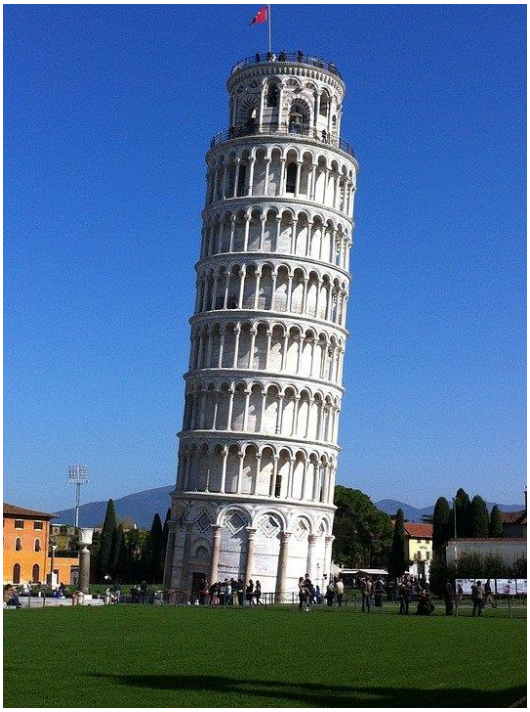
The Leaning Tower of Pisa



Phenomena description:
The **Leaning Tower of Pisa** is one of the most remarkable architectural structures from medieval Europe. It is located in the Italian town of Pisa, one of the most visited European cities.

In 1990, the Italian government enlisted top engineers to stabilize Pisa's famous Leaning Tower. There had been many attempts during its' 800 year history, but computer models revealed the urgency of their situation. The tower would topple if it reached an angle of 5.44 degrees— and it was currently leaning at 5.5! What gives the tower its infamous tilt?

Phenomena video:
Watch this video to explore the monument's history.
https://www.youtube.com/watch?v=HmMdb_9omqc

Source:
https://ed.ted.com/lessons/why-doesn-t-the-leaning-tower-of-pisa-fall-over-alex-gendler
http://www.towerofpisa.org/tower-of-pisa-historical-facts/

Leaning Tower of Pisa

The **Leaning Tower of Pisa** is one of the most remarkable architectural structures from medieval Europe. It is located in the Italian town of Pisa, one of the most visited European cities.

WHEN was the leaning Tower of Pisa built?

The construction of the Leaning Tower of Pisa began in August 1173. It was interrupted several times by wars, debt and while engineers worked on solutions to correct the lean. We now know that without these interruptions that allowed the soil to compress under the tower, it would have certainly toppled over. Pisa Tower was eventually completed in the mid-1300s.

Leaning Tower of Pisa

WHY was the leaning Tower of Pisa built?

The Tower of Pisa is the churches belltower. The city of Pisa was at the beginning a simple but important Italian seaport. With its' growth, so did its' religious buildings. Its' fame and power grew gradually over the years, as the people of Pisa were involved in various military conflicts and trade agreements. The Pisans attacked the city of Palermo on the island of Sicily in 1063. The attack was successful and the conquerors returned to Pisa with a great deal of treasure. To show the world just how important the city was, the people of Pisa decided to build a great cathedral complex, the Field of Miracles. The plan included a cathedral, a baptistery, a bell tower (the Tower of Pisa) and a cemetery.

WHO built the leaning tower of Pisa?

The real identity of Tower of Pisa's architects is a mystery. The most accredited architects of this first phase of work are Bonanno Pisano and Gherardo din Gherardo. The second phase of construction started in 1275, and the work is attributed to Giovani di Simone. Tommaso Pisano (1350-1372) was the architect who finished the work.

WHY does the Tower of Pisa lean?

The leaning of the Tower of Pisa comes into the story in 1173, when construction began. Thanks to the soft ground, it had begun to lean by the time its' builders got to the third story, in 1178. Shifting soil had destabilized the tower's foundations. Over the next 800 years, it became clear the 55-metre tower wasn't just learning but was actually falling at a rate of one to two millimeters per year. Today, the Leaning Tower of Pisa is more than five meters off perpendicular. Its' architect and engineer tried to correct this by making the remaining stories shorter on the uphill side – but to no avail. It kept leaning more and more. The lean, first noted when three of the tower's eight stories had been built, resulted from the foundation stones being laid on soft ground consisting of clay, fine sand and shells. The next stories were built slightly taller on the short side of the tower in an attempt to compensate for the lean. However, the weight of the extra floors caused the edifice to sink further and lean more.

Many ideas have been suggested to straighten the Tower of Pisa, including taking it apart stone by stone and rebuilding it at a different location. In the 1920s the foundations of the tower were injected with cement grouting that has stabilized the tower to some extent. Until recent years tourists were not allowed to climb the staircase inside the tower, due to consolidation work.

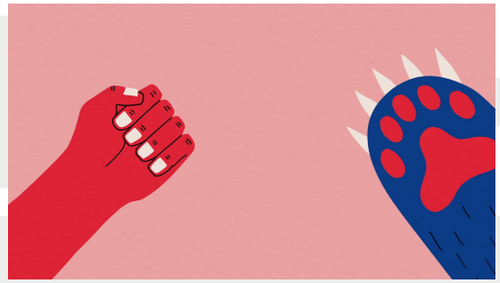
Source:

http://www.towerofpisa.org/tower-of-pisa-historical-facts/

READ THIS

1 Week 9 Phenomena: Claws vs. Nails

Read and/or watch the phenomena introduction



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Pick one of these CCCs:

- Cause and Effect
- Stability and Change
- Structure and Function

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Claws vs Nails

Phenomena Description:
Primates are a group of mammals that have many adaptations for an arboreal ("tree-living") lifestyle. Nails are an adaptation that helps primates firmly grasp tree branches as they climb, but there are other traits that primates have that help them high off the ground.
Now, let's consider the claw. Frequently found on animals around the world, it's one of nature's most versatile tools. Bears use claws for digging as well as defense. An eagle's needle-like talons can pierce the skulls of their prey. Even the ancestors of primates used to wield these impressive appendages, until their claws evolved into nails. So, what caused this adaptation?

Humans are primates and we have nails. But what if humans developed claws? How would our lives be affected? Hmmm……


Hand Rake

Well, think about gardening. Have you ever noticed that people who enjoy gardening commonly use tools that are similar to claws. You're probably familiar with some of the tools used by gardeners such as planting gloves, hand cultivators and hand rakes.


Hand Cultivator

But have you ever seen gardening glove claws? The image on the right is a picture of gardening glove claws. What do you notice about these gloves? What do you think are the benefits of these gloves for gardeners? As you probably noticed, this specialized pair of gardening gloves make the digging and turning of soil fast and easy, without the use of tools, while also protecting your hands. The integrated claws make it easy to dig into dirt faster in order to transfer plants or start seedlings. These gloves work wonderfully for picking fruits and holding thorny stems. With their claw-shaped design, they can dig through soil in no time at all, so planting and transferring plants is a breeze.

Gardening Glove Claws

So, there are definitely advantages to having claws. But what about nails? Can nails be used in the same way as claws? Do claws and nails have any similarities? Where did claws and nails come from? We'll explore these questions as we learn more about claws and nails.

Source:
https://www.inspireuplift.com/products/claws-garden-gloves

Phenomena video:
Watch this video to see the glove claw in action. As you watch, think about the advantages of having claws. What are some advantages to having nails?

https://www.youtube.com/watch?v=_ydlqDCn_hg

Claws vs Nails

Your fingernails and toenails are evidence that you are a primate, part of the group of mammals that includes lemurs, monkeys, and apes. Most mammals and reptiles have claws at the ends of their fingers and toes. Where did these nail things come from, and how did they help primates along our evolutionary journey?

Primate Adaptations

Primates are a group of mammals that have many adaptations for an arboreal ("tree-living") lifestyle. Primates also have forward-facing eyes that help us perceive depth in three dimensions. Forward-facing eyes are possible because primates have relatively small snouts compared to many other mammals.

Primates also have relatively large brains for their body size, which help them navigate their complex environment and keep track of social relationships. These big brains also help primates interpret all the sensory information they are receiving from their nerve-infused, highly sensitive finger pads.

Finally, primates all have opposable thumbs and opposable big-toes. That means the pad of the first digit on a primate's hand or foot can touch the pad of other digits. Humans are primates, but we lack opposable toes. We know from the structure of the muscles in our feet that our ancestors had grasping feet, but as our lineage adapted to walking on the ground, the big toe aligned with the rest of our toes to give us a solid platform and lever for vaulting us forward with each step.

Some other mammal groups have primate-like traits. Some possums have opposable thumbs and lack claws and cats have forward-facing eyes, but primates are the only group that combine all of these traits in one lineage.

Claws to Nails to Claws

One of the first nail-bearing primate relatives was Carpolestes. Carpolestes belonged a group of mammals called plesiadapiforms. It had an opposable big toe and nails on its feet, but not yet on its hands. A few million years later, the first true primates evolved, animals like Teilhardina and Notharctus. Based on the fossil record, paleontologists know the ancestors of all primates had nails on their hands and feet, but some primate lineages have retained a few claws, or re-evolved the structures. Marmosets and tamarins are small, South American monkeys that have long claws that help them scamper up large tree trunks like squirrels (squirrels are a type of rodent).

Lemurs are a group of primates that live in Madagascar. They have one claw on each foot that is called a "grooming claw" or a "toilet claw" because they use it to clean themselves. One lemur has more than a grooming claw: the aye-aye. Aye-ayes – like marmosets – have only claws on their hands and no nails. Aye-ayes use these claws to help them skewer their insect prey. Aye-ayes hunt by listening for insects with their large ears, then burrowing into the tree trunk with their rodent-like, ever growing front teeth. They reach their fingers into the hole to fish out their food. Check out this video of an aye-aye feeding.

Why Do We Have Fingernails?
When painted, they can add a girly sparkle to hands, and for some people they can substitute as a guitar pick or even a backscratcher. These savvy services, though, are not the reason we humans sport the keratin-rich coverings atop our fingertips. "We have fingernails because we're primates," said John Hawks, a biological anthropologist at the University of Wisconsin-Madison. Fingernails are one of the features that distinguish primates, including humans, from other mammals. They are essentially flattened forms of claws. "Most mammals have claws. [They] use them to grab onto things, to climb things, to scratch things, and to dig holes" Hawk said.

Scientists suspect primates sort of lost their claws and fashioned broad fingertips topped with nails to aid in locomotion. While claws would have provided excellent grip as our mammalian ancestors clambered up large tree trunks, they would have been a nuisance for larger-bodied primates trying to grasp smaller branches while scrambling across tree canopies for fruits. Rather, primates developed broader fingertips made for grasping.

About 2.5 million years ago, fossil evidence suggests early humans first picked up stone tools, which is about the same time our ancestors also developed even broader fingertips than earlier primates. To this day, humans sport broader fingertips than other primates.

Whether fingernails are an adaptation that helps to support broad fingertips or a side effect from the loss of claws is unclear, Hawks said. Another reason for fingernails: They serve as a visual advertisement of a person's health, he said. For instance, malnutrition can change the coloring of nails, while small pits in fingernails can signal the skin condition psoriasis.

Why do I need to trim my fingernails?

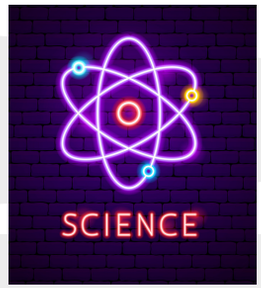
Hair and nails are both derived from keratin. In keratinous structures, active growth occurs at the base of the structure. Keratinous structures cannot repair themselves internally because they do not have nerves or a blood supply throughout their length. Bone – unlike keratin – has nerves and a blood supply that allows it to repair itself. That means the only way to “repair” a nail or hair is to keep growing it out. Most animals wear down their nails or claws with use over time, so they don’t really need to trim them. They just extrude a new nail and wear down an old nail. If an animal does need to trim a claw or nail, they may bite it, just like we do, though we have also developed handy tools that help us trim our nails when it’s time.

Source:
https://ed.ted.com/lessons/claws-vs-nails-matthew-borths#digdeeper
https://www.livescience.com/32472-why-do-we-have-fingernails.html by Jeanna Bryner

READ THIS

1 Week 10 Phenomena: Neon Signs

Read and/or watch the phenomena introduction



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7 Which Cross Cutting Concept will you learn more about this week? You should choose a new one each week.

Pick one of these CCCs:

- Patterns
- Energy and Matter
- Systems and System Models

8 Read and/or watch the provided videos to learn more about the Cross Cutting Concept (CCC) then complete the graphic organizer associated with that CCC. Use this week's phenomena to complete the graphic organizer.

What Makes Neon Signs Glow?

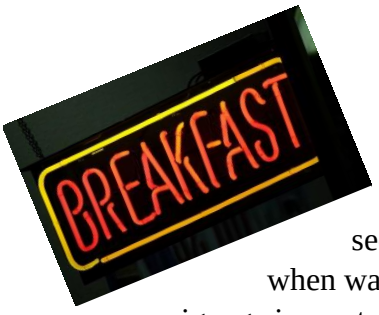
Phenomena description:
When the Hoover Dam was completed, it created a huge source of hydroelectric power and zapped a sleepy desert town to life: Las Vegas, Nevada. With the power supply from the dam, Las Vegas soon exploded with vibrant displays. The source of these dazzling lights was electrified neon gas.

Neon (Ne) is a colorless and odorless gas. It is commonly considered one of the fun elements of the periodic table. Chances are that whenever you see a glowing sign, it's probably neon. Neon is used to make a variety of things. Neon is used in lighting signs that are often called "neon" signs and is used in glow lamps. If you've ever watched TV on an old television set, you may not know that neon is one of the elements inside the TV tube. Neon is also used in lasers. Scientists use those lasers in experiments. Doctors also use them to do surgery. When you see a doctor using a red light on someone... It might be a laser!

If neon is a colorless gas, how does it make signs glow?

Source: http://www.chem4kids.com/files/elements/010_speak.html

Phenomena video:
Watch this video to explore the colorful world of neon signs of Las Vegas, Nevada.
https://www.youtube.com/watch?v=VnUhKxRiBuM



What Makes Neon Signs Glow?

Chances are good that you've grown up seeing some form of neon lighting in your town. But when was the last time you stopped to consider how that particular type of signage is created and by whom? Neon signs have always been individually made by hand and they still are. Even corporate signage for national beer brands or chain stores create their neon by hand. There is still no method to produce neon signage by machine on an assembly line. It's a handcrafted art form.

History

Neon signs first became popular in the 1930s because their piercing light was visible from a long distance. Consumers in fast-moving automobiles could identify a lit sign from far away and still have time to pull over and patronize the business. Additionally, neon production was cheap and the illuminated gas lasted much longer (up to 40 years!) than the incandescent lighting that was popular around the turn of the last century.

Neon In Your Town

A big part of neon's charm is the way that different craftspeople come together to create some seriously stunning results. A typical neon sign utilizes the talents of graphic design, font manipulation, sheet metal fabrication, electrical engineering, color theory, animation, and most especially the talents of the hot glass fabricators, the "tube benders" themselves. Each tube bender has to map out their own individual course of action when looking at a particular sign's design and lighting structure. Though there may be two signs that look very similar (say, a "SHOES" sign) each one will have its glass bent in accordance with that particular craftsperson's idea of how best to manage the unwieldy and fragile tubes of glass. Where to make edits in a letter, and how long to run a continuous tube before heating up another to continue the letterform(s) are all decisions which are unique to the individual tube bender. Even when there is an industry standardized plan of attack for laying out the bending method of a particular sign, the actual path to completion is always decided by the assigned tube bender. This is why close inspection of a neon sign is so rewarding. It's possible to see the thought processes involved in the manufacture of a sign that would have been easy to dismiss as "just another sign" on first glance. A deeper dig into the mental and physical attention devoted to the fabrication of a neon sign is a surprisingly rich experience.

Neon has been the subject of renewed interest and preservation in the past few years. Some cities have their own organizations devoted to the mapping and renovation of historically important and at-risk neon signs in their town. There is even a museum dedicated to neon as a cultural art form in the Los Angeles area.

How Do Neon Lights Work?
Neon lights are made from glass tubes that are filled with inert gases, which are gases that won't react when combined with other chemicals. Commonly used with neon gas, neon lights can be filled with argon and krypton (yes, Superman's only weakness). After the gas has filled the tube of glass, a few electrodes are put on the end of the tube (electrodes are electrical conductors used to act as a doorway for electricity to enter and exit the object).

When the neon light is turned on, electricity rushes from the power source through the electrodes and into the glass tube. At this point, the electricity combines with the gases and the atoms within the glass begin to light up, creating a radiant glow that floods the area. Once this process was discovered, glass tubes would be bent and twisted (at an extremely high heat of 800-900 degrees Celsius) into words to make up signs, and artistic designs. This led the way for many storefronts, shops, and restaurants to stand out from the crowd, grab attention, and entice those walking by to come in.

How Do Neon Signs Have Different Colors?
To make different colors of neon tubes, different gases are combined with electricity to form the light, each type of gas produces a different color:

- Neon gas creates a red glow
- Argon gas creates a light blue glow
- Krypton gas creates a bright white glow

The color of the neon light can also be altered by using colored fluorescent lights within the glass tube. Or, by using different colored glass tubes, it can create a different shade of light.

Sources:
https://ledlightguides.com/how-do-neon-lights-work/
https://ed.ted.com/lessons/what-makes-neon-signs-glow-a-360-animation-michael-lipman#digdeeper

READ THIS

CCC:SYSTEM AND SYSTEM MODELS

Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

Systems and System Models are useful in science and engineering because the world is complex, so it is helpful to isolate a single system and construct a simplified model of it. "To do this, scientists and engineers imagine an artificial boundary between the system in question and everything else. They then examine the system in detail while treating the effects of things outside the boundary as either forces acting on the system or flows of matter and energy across it—for example, the gravitational force due to Earth on a book lying on a table or the carbon dioxide expelled by an organism.

WATCH THIS

http://www.bozemanscience.com/ngs-systems-system-models

Consideration of flows into and out of the system is a crucial element of system design. In the laboratory or even in field research, the extent to which a system under study can be physically isolated or external conditions controlled is an important element of the design of an investigation and interpretation of results...The properties and behavior of the whole system can be very different from those of any of its parts, and large systems may have emergent properties, such as the shape of a tree, that cannot be predicted in detail from knowledge about the components and their interactions." (p. 92) (Framework for K-12 Science Education)

Discussion Questions:

- What are the key parts of the phenomena?
  - How do these parts work together?
  - How do the parts work independently?
- What would happen in the phenomena if you changed one of the key components?
- What is the boundary of this phenomena?
- What is being added to the system to make the phenomena occur? (Inputs)
- What is leaving the system during the phenomena? (Outputs)
- What kind of energy is being used in this phenomenon?

**These questions should help guide you in creating the CCC graphic organizer*

CCC:CAUSE AND EFFECT

Mechanism and explanation. Events have causes, sometimes simple, sometimes more complex. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are changed. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Cause and effect is often the next step in science, after a discovery of patterns or events that occur together with regularity. A search for the underlying cause of a phenomenon has sparked some of the most compelling and productive scientific investigations. "Any tentative answer, or 'hypothesis,' that A causes B requires a model or mechanism for the chain of interactions that connect A and B. For example, the notion that diseases can be transmitted by a person's touch was initially treated with skepticism by the medical profession for lack of a likely mechanism.

WATCH THIS

http://www.bozemanscience.com/ngs-cause-effect-mechanism-and-explanation

Today infectious diseases are well understood as being transmitted by the passing of microscopic organisms (bacteria or viruses) between an infected person to another person. A major activity of science is to uncover such causal connections, often with the hope that understanding the mechanisms will enable predictions and, in the case of infectious diseases, the design of preventive measures, treatments, and cures." (p. 87) (Framework for K-12 Science Education)

Discussion Questions:

- Did you notice a pattern in the phenomena where _____ caused _____?
  - How do you know _____ caused _____?
- How could you test if _____ caused _____?
- How would one of the components changing cause the phenomena to change?
- What scientific rule or property is causing this cause and effect relationship?
  - Is there something microscopic or macroscopic happening to cause this phenomena?
- How does the relationship change over time?
- Does this cause and effect relationship happen in other phenomena around you?
- What is the condition or component that changes that causes the phenomena to occur?

*These questions should help guide you in creating the CCC graphic organizer

CCC:ENERGY AND MATTER

Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

Energy and Matter are essential concepts in all disciplines of science and engineering, often in connection with systems. "The supply of energy and of each needed chemical element restricts a system's operation—for example, without inputs of energy (sunlight) and matter (carbon dioxide and water), a plant cannot grow. Hence, it is very informative to track the transfers of matter and energy within, into, or out of any system under study."In many systems there also are cycles of various types. In some cases, the most readily observable cycling may be of matter—for example, water going back and forth between Earth's atmosphere and its surface and subsurface reservoirs. Any such cycle of matter also involves associated energy transfers at each stage, so to fully understand the water cycle, one must model not only how water moves between parts of the system but also the energy transfer mechanisms that are critical for that motion.

WATCH THIS

http://www.bozemanscience.com/ngs-energy-matter-flows-cycles-and-conservation

"Consideration of energy and matter inputs, outputs, and flows or transfers within a system or process are equally important for engineering. A major goal in design is to maximize certain types of energy output while minimizing others, in order to minimize the energy inputs needed to achieve a desired task." (p. 95) (Framework for K-12 Science Education)

Discussion Questions:

- What kind of energy do you notice within this phenomenon?
  - What kind of energy is put in to make the phenomena happen?
  - What kind of energy is made from the phenomena happening?
- What kinds of materials are within the phenomenon?
  - What state of matter (solid, liquid, or gas) is included in the phenomenon?
- How does energy flow through the system?
- Where is new matter coming from?
- Is there a change in molecules in this phenomenon?

**These questions should help guide you in creating the CCC graphic organizer*

CCC:SCALE, PROPORTION AND QUANTITY

In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Scale, Proportion and Quantity are important in both science and engineering. These are fundamental assessments of dimension that form the foundation of observations about nature. Before an analysis of function or process can be made (the how or why), it is necessary to identify the what. These concepts are the starting point for scientific understanding, whether it is of a total system or its individual components. Any student who has ever played the game "twenty questions" understands this inherently, asking questions such as, "Is it bigger than a bread box?" in order to first determine the object's size.

WATCH THIS

http://www.bozemanscience.com/ngs-scale-proportion-quantity

An understanding of scale involves not only understanding systems and processes vary in size, time span, and energy, but also different mechanisms operate at different scales. "The ideas of ratio and proportionality as used in science can extend and challenge a student scientist's mathematical understanding of these concepts. To appreciate the relative magnitude of some properties or processes, it may be necessary to grasp the relationships among different types of quantities—for example, speed as the ratio of distance traveled to time taken, density as a ratio of mass to volume. This use of ratio is quite different than a ratio of numbers describing fractions of a pie. Recognition of such relationships among different quantities is a key step in forming mathematical models that interpret scientific data." (p. 90) (Framework for K-12 Science Education)

Discussion Questions:

- What size are the components in this phenomena?
  - Can you imagine what this phenomena looks like at the microscopic level? At the macroscopic level?
- Does the phenomena happen quickly or over time?
- How does the quantity of energy into the system impact the phenomena?
- What is the ratio between _____ and _____ in this phenomenon?
- How could you draw a model to represent the scale, proportion, or quantity represented in the phenomena?

**These questions should help guide you in creating the CCC graphic organizer*

CCC:PATTERNS

Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

WATCH THIS

http://www.bozemanscience.com/ngs-patterns

Patterns exist everywhere—in regularly occurring shapes or structures and in repeating events and relationships. For example, patterns are recognizeable in the symmetry of flowers and snowflakes, the cycling of the seasons, and the repeated base pair structure of DNA.

In some cases, order seems to emerge from chaos, as when a plant sprouts, or a tornado appears amidst scattered storm clouds. It is in such examples that patterns exist and the beauty of nature is found. “Noticing patterns is often a first step to organizing phenomena and asking scientific questions about why and how the patterns occur. Once patterns and variations have been noted, they lead to questions; scientists seek explanations for observed patterns and for the similarity and diversity within them. (Framework for K-12 Science Education)

Discussion Questions:

- What patterns do you recognize in the phenomena?
- What similarities and differences can you identify within the phenomena?
  - What categories could you create to help understand the phenomena?
- How is the phenomena changing over time?
- Can you make a prediction about how this pattern might apply to another phenomena?
- Can you use a mathmatical equation to represent this pattern?
- Is there a pattern in the relationship between two or more components in the phenomena?
- What does the pattern in the phenomena help you to conclude?
- How do the properties of the components within the phenomena determine the pattern?

*These questions should help guide you in creating the CCC graphic organizer

CCC:STABILITY AND CHANGE

For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Stability and Change are the primary concerns of many, if not most scientific and engineering endeavors. “Stability denotes a condition in which some aspects of a system are unchanging, at least at the scale of observation. Stability means that a small disturbance will fade away—that is, the system will stay in, or return to, the stable condition. Such stability can take different forms, with the simplest being a static equilibrium, such as a ladder leaning on a wall. By contrast, a system with steady inflows and outflows (i.e., constant conditions) is said to be in dynamic equilibrium. For example, a dam may be at a constant level with steady quantities of water coming in and out. . . . A repeating pattern of cyclic change—such as the moon orbiting Earth—can also be seen as a stable situation, even though it is clearly not static.

WATCH THIS

http://www.bozemanscience.com/ngs-stability-change

“An understanding of dynamic equilibrium is crucial to understanding the major issues in any complex system—for example, population dynamics in an ecosystem or the relationship between the level of atmospheric carbon dioxide and Earth’s average temperature. Dynamic equilibrium is an equally important concept for understanding the physical forces in matter. Stable matter is a system of atoms in dynamic equilibrium.“ In designing systems for stable operation, the mechanisms of external controls and internal ‘feedback’ loops are important design elements; feedback is important to understanding natural systems as well. A feedback loop is any mechanism in which a condition triggers some action that causes a change in that same condition, such as the temperature of a room triggering the thermostatic control that turns the room’s heater on or off. (Framework for K-12 Science Education)

Discussion Questions:

- Is the system described in the scenario stable or unstable? What is your evidence?
- Can you identify stability and change within the phenomena?
- What factors cause the phenomena to change?
- What factors cause the phenomena to remain stable?
- What is happening at the microscopic (small) level that might cause the phenomena to change?
  - the macroscopic (big picture) level?
- How does the phenomena change over time?
- What might cause the phenomena to become unbalanced?

**These questions should help guide you in creating the CCC graphic organizer*

CCC:STRUCTURE AND FUNCTION

The way in which an object or living thing is shaped and the different parts that make it up determine many of its properties and functions. How it's built affects what it does.

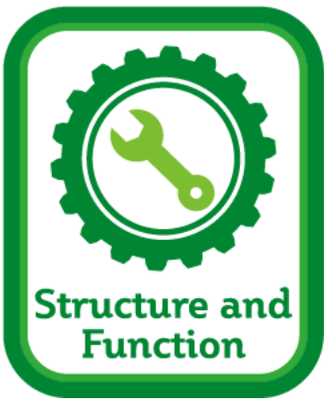
Structure and Function are properties that always work together.

"The shape and stability of things that people make or occur naturally in the wild are related to their function(s). How these natural and built systems work depends on the shapes and relationships of certain key parts as well as on the properties of the materials from which they are made. A sense of scale is necessary in order to know what properties and what aspects of shape or material are relevant at a particular magnitude or in investigating particular phenomena— that is, the selection of an appropriate scale depends on the question being asked.

For example, the way molecules are organized is not particularly important in understanding the phenomenon of pressure, but they are relevant to understanding why the ratio between temperature and pressure at constant volume is different for different chemicals (more complicated stuff!).

WATCH THIS

http://www.bozemanscience.com/ngs-structure-function



"Similarly, understanding how a bicycle works is best addressed by examining the structures and their functions at the scale of, say, the frame, wheels, and pedals. However, building a lighter bicycle may require knowledge of the properties (such as rigidity and hardness) of the materials needed for specific parts of the bicycle. In that way, the builder can seek less dense materials with appropriate properties; this pursuit may lead in turn to an examination of the atomic-scale structure of candidate materials. As a result, new parts with the desired properties, possibly made of new materials, can be designed and fabricated." (p. 96-97)(Framework for K-12 Science Education)

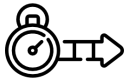
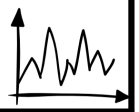
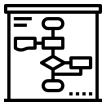
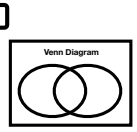
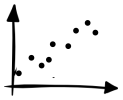
Discussion Questions:

- What structures are present in the phenomenon?
- What is the function of these structures?
- How does the structure help with the function?
  - How does the shape help?
  - How does the material help?
- Are there any microscopic (tiny) structures that help this phenomenon occur?

**These questions should help guide you in creating the CCC graphic organizer*

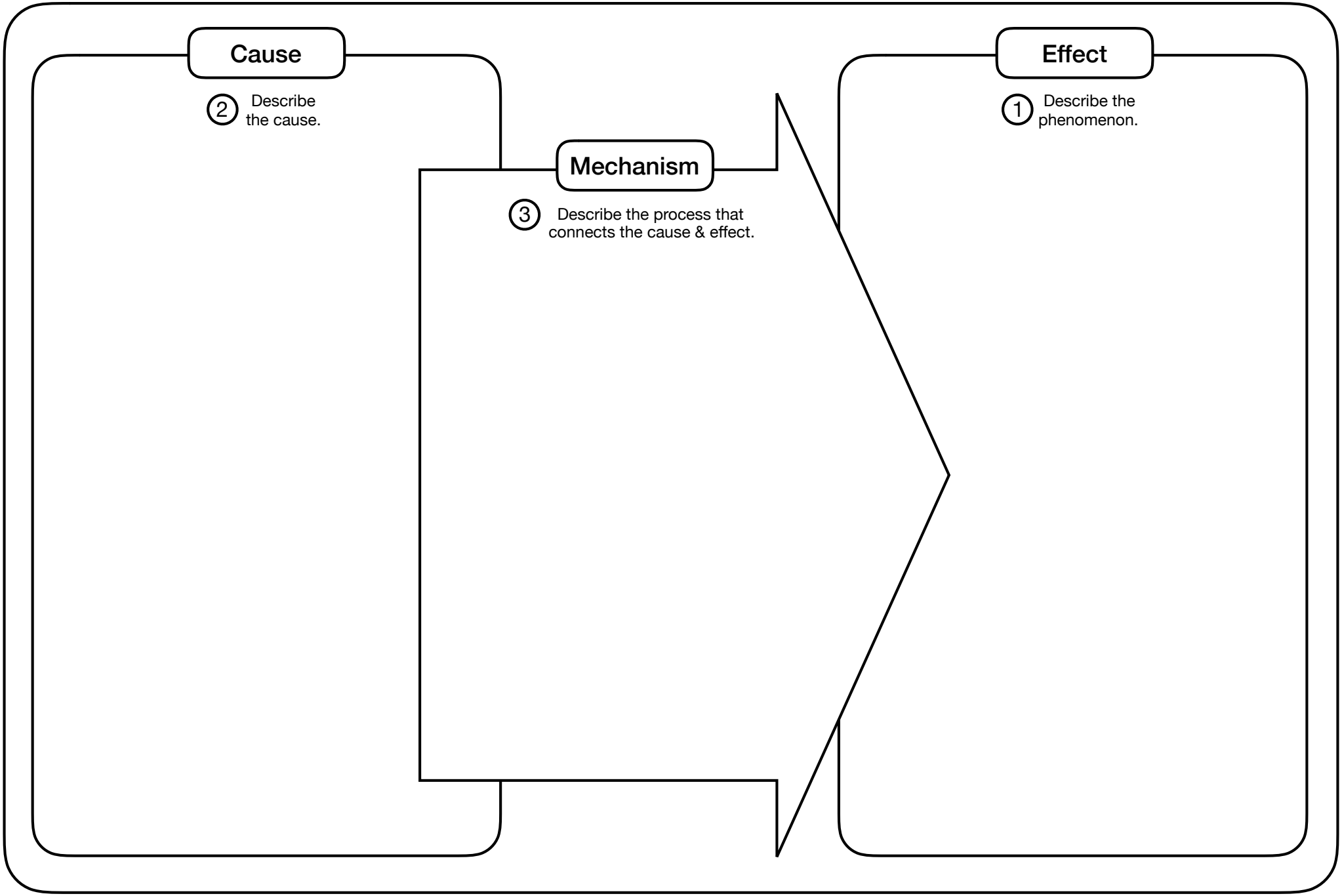
Patterns

1 Describe the **Phenomenon**

2 Which kind of pattern have you identified?	3 How will you represent this pattern?	
☐ Time Pattern	☐ 	☐ 
	☐ 	☐ 
☐ Spatial Pattern	☐ 	☐ 
	☐ 	☐ 
☐ Properties	☐ 	☐ 
☐ Relationship	☐ 	☐ 
Other		

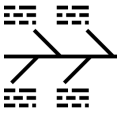
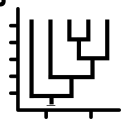
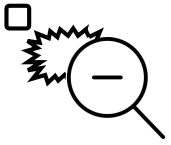
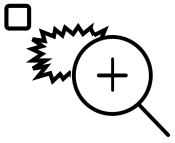
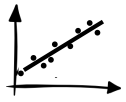
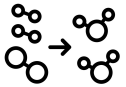
4 **Representation**

Cause and Effect



Scale, Proportion, Quantity

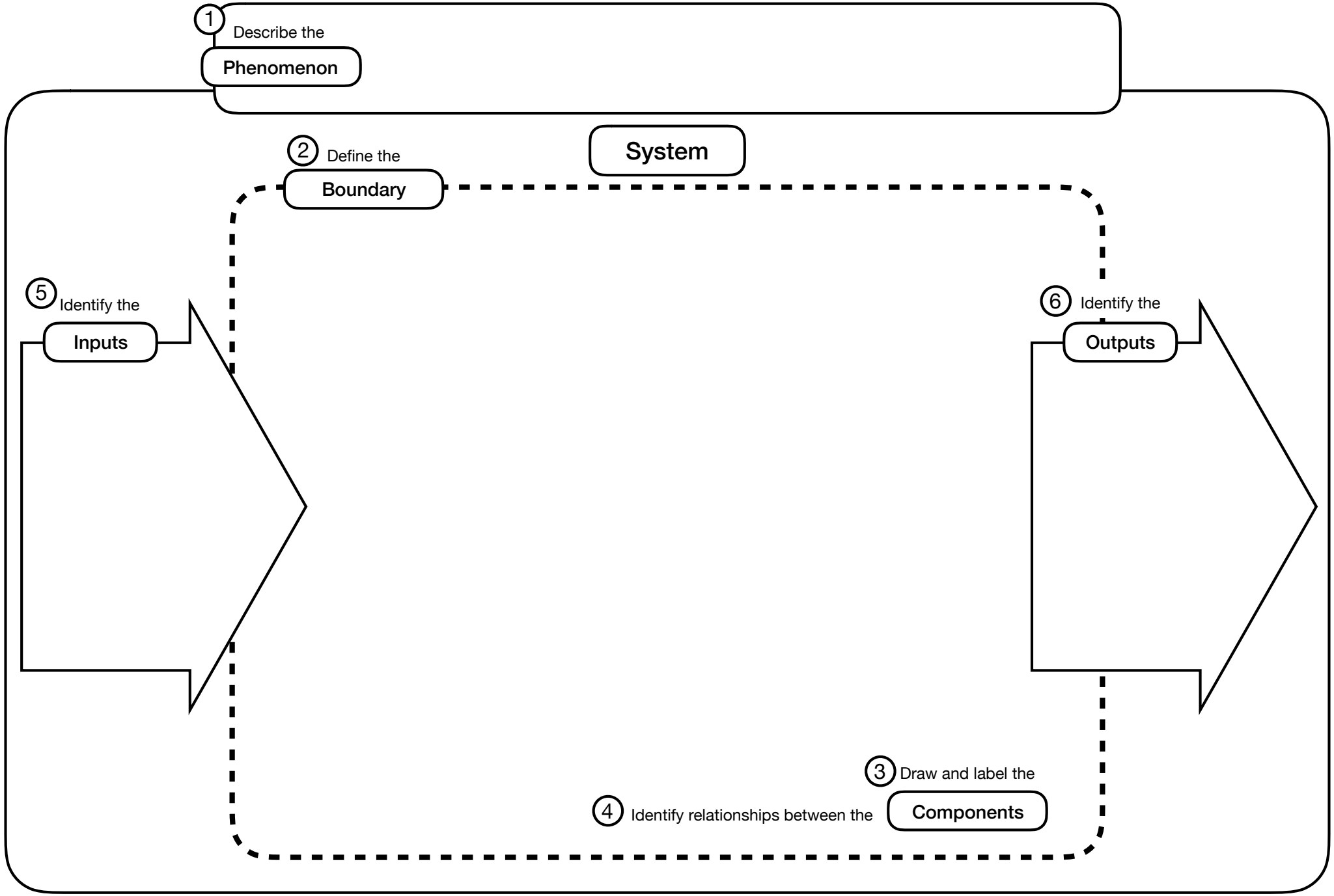
1 Describe the **Phenomenon**

2 Which of the following is relevant to the system?	3 How will you represent this relevance?	
☐  Size Scale	☐  Astronomic	☐  Macroscopic
	☐  Microscopic	☐  Atomic
☐  Time Scale	☐ 	☐ 
☐  Scale	☐ 	☐ 
☐ $y \propto x$ Proportion	☐ 	☐ f_x
☐  Quantity	☐ 	☐ 

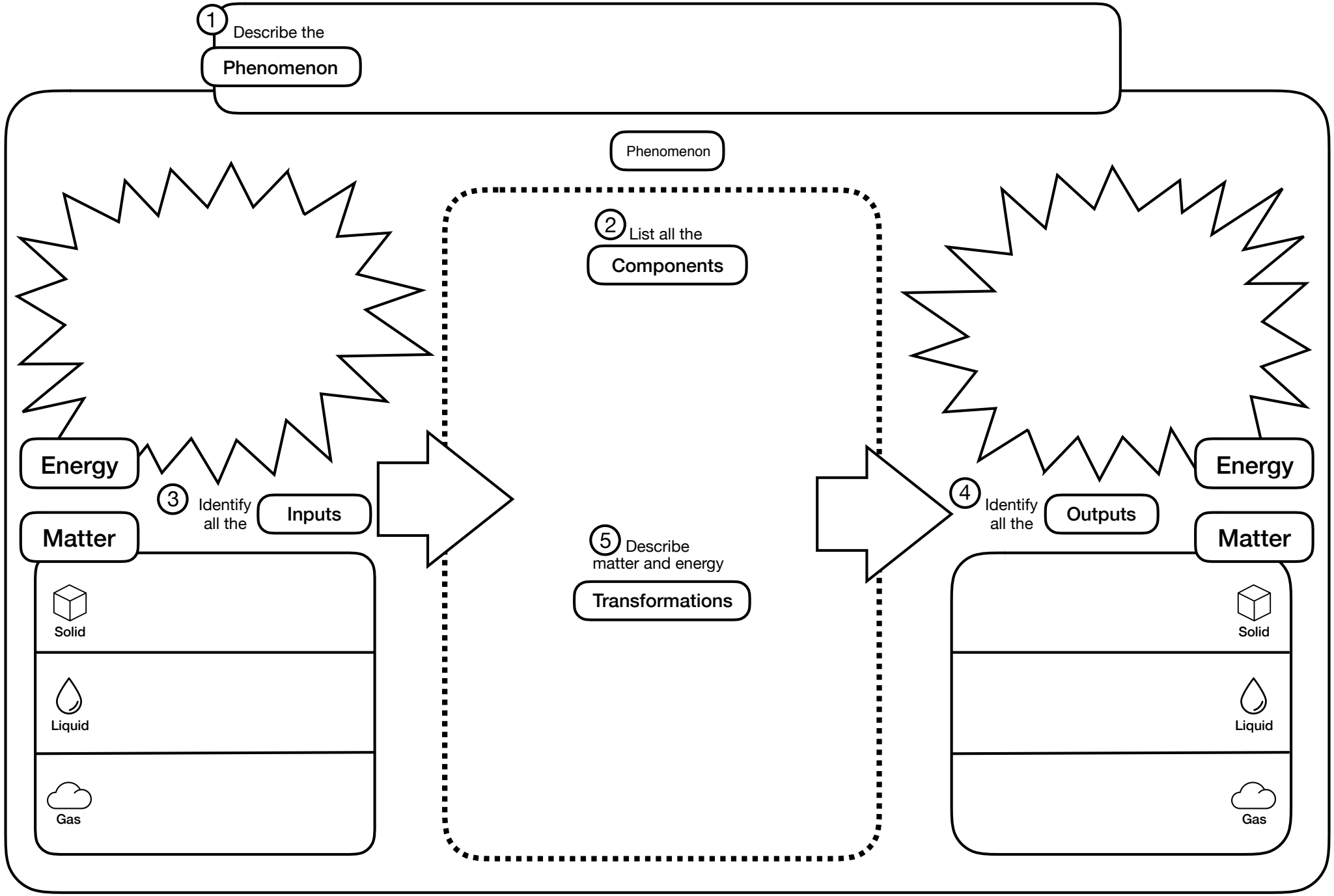
System

4 **Representation**

Systems and System Models



Energy and Matter



Structure and Function

1. Describe the **Phenomenon**

Structure

2. Draw and label the structure.

4. Describe the process that connects the structure and function using the following words.

Determines →

← Depends On

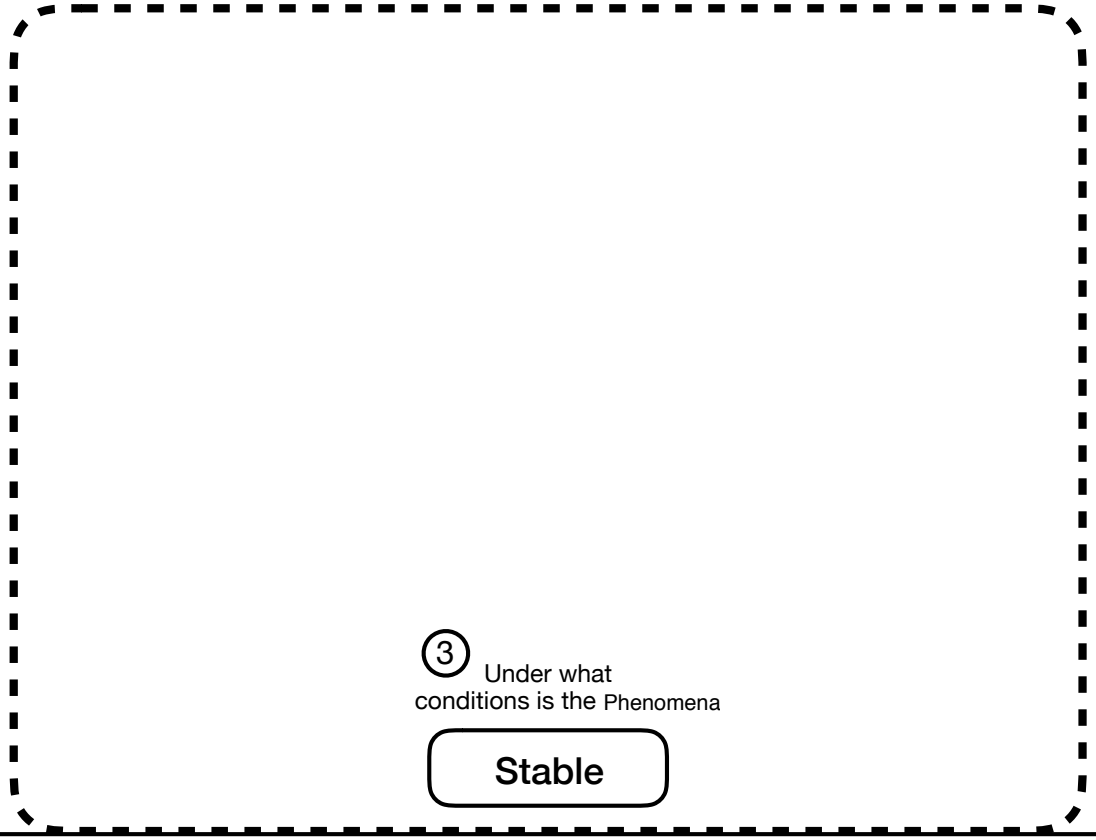
Function

3. Describe the function.

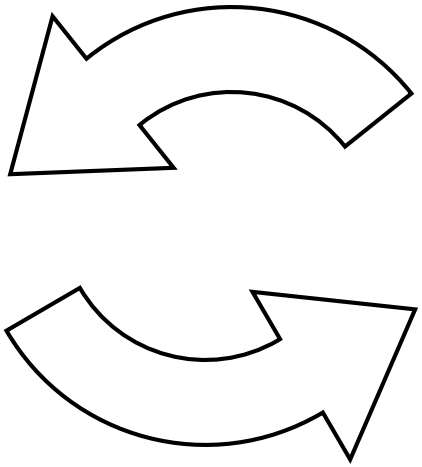
Stability and Change

1. Describe the **Phenomenon**

2. Define the **Components of the phenomena**



3. Under what conditions is the Phenomena **Stable**



4. Under what conditions does the Phenomena **Change**

5. What happens to cause the phenomena to become stable again?

Scientific Models

An additional practice identified in the Framework for K–12 Science Education is developing and using scientific models. Modeling is a multifaceted practice that is integral to scientific work. Scientists develop models to support explanations and make predictions about complex phenomena. Models are representations of objects, processes, or phenomena that resemble in appearance and/or function, describe, or explain the *real* thing. An authentic model must include some form of visual representation, such as a diagram, graph, equation, or simulation and must connect observations and/or explanations with the associated components. A model is **not** a generic or "posterized" version of reproduceable textbook explanations. They should include both observable and non-observable features of a specific set of circumstances or ideas in order to be valid.

While students may often encounter scientific models virtually or in print, students will require support in developing and making connections to their ***own*** models, with relation to a given phenomenon. To support students' development and use of scientific models in more sophisticated ways, there are three aspects of modeling which should be considered when incorporating this practice into your classroom: components, relationships, and connections. See the example of a modeling rubric for further explanation.

This is an example of a real student's model

Scientific Modeling Rubric (Example)	**Level 1** Does not meet standard	**Level 2** Approaching standard	**Level 3** Meeting standard	**Level 4** Advanced understanding
Components	Contains no necessary components	Contains some necessary components	Contains all (visible/invisible) necessary components with some unnecessary components	Contains all (visible/invisible) necessary components with no unnecessary components
Relationships	Contains no relationships between components. (*These models are simply reproduced, textbook explanations or posters.)	Contains most relationships between the necessary components	Accurately represents all relationships between necessary components	Includes various methods of demonstrating all relationships between necessary components (arrows, keys, equations, explanations).
Connection to Phenomenon	Contains no connection to the phenomenon.	Minimally explains the connected phenomenon.	Explains the connected phenomenon in detail.	Makes predictions about phenomenon.