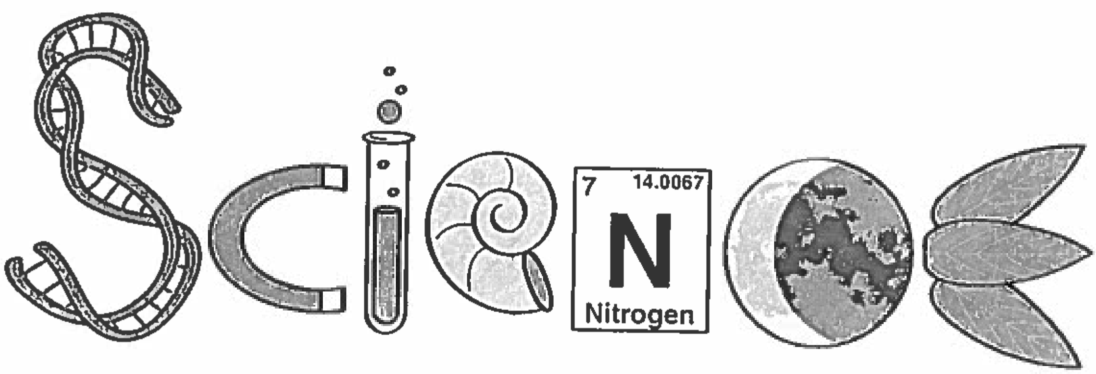
Lathrop Intermediate

7th grade Science
1st Semester



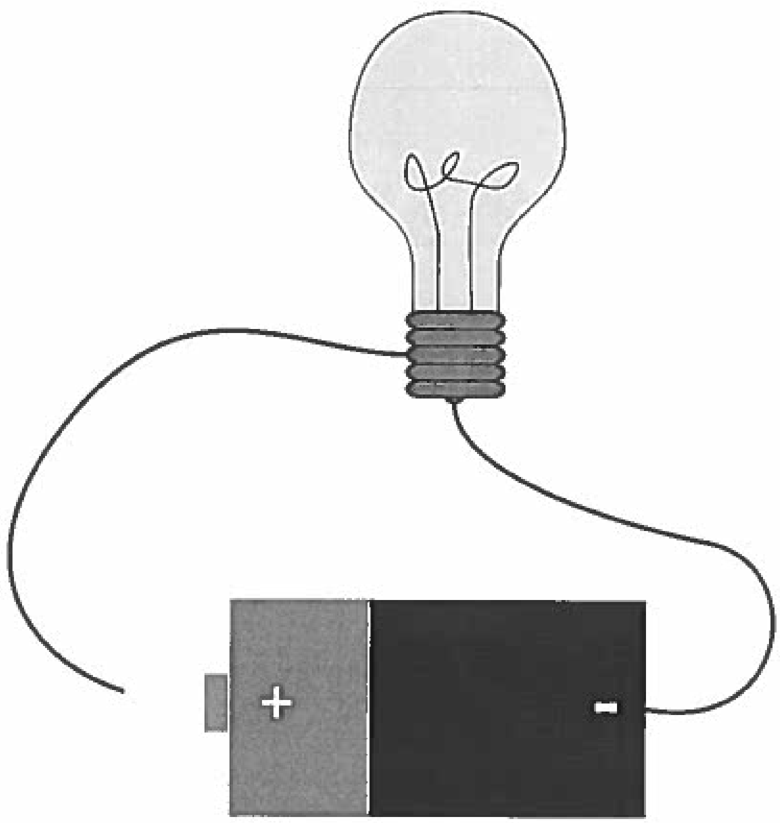
Name: ______________________________

Teacher: ______________________________

Period: ______________________________

Lathrop Intermediate

7th grade Science
Engineering Unit



7.0.0 Task - Building a Circuit (Print 2 copies and place in plastic sleeves)

Guiding Question: How do we talk and work together like engineers?

Introduction

Have you ever flipped on a light switch or used a fan? Have you ever wondered what the engineers needed to think about in order to build a device that works? Throughout the year you will be asked to think and work like an engineer to design and build different types of things to solve a specific problem.

Task

Build a circuit out of the given materials

Time: 55-minutes

Materials: (per group) Required materials: • Light bulb • D-battery • 30cm of tape	Select Materials: • Rubber bands • Pieces of styrofoam • Paperclips • Balls of clay • Copper wire • "Lead" for a mechanical pencil

Procedure:

1. Explore all the materials (5-minutes)
2. Use the Quiet Brainstorm & Academic Discussion Scaffolds to create a model (10-minutes)
3. Building a Prototype (15-minutes)
4. Prototype Analysis (10-minutes)
    a. As a class, record observations in the data table and analyze each prototype.

Circuit Prototype Evaluation Criteria	
Materials	You can only use two items from the select materials list. For example, 2 rubber bands or 1 rubber band and 1 paperclip.
Test	Does the light turn on?

Reflection: (10-minutes)

Teamwork

- Complete the Collaboration and Teamwork Rubric.
- As a team, be prepared to share your team's thinking and decision-making process.

Individual Reflective Questions

Answer the following questions individually in your notebook.

Circuit Prototype Redesign Graphic Organizer

Name: ______________________________ Period: ____ Date: __________

Design 1	*Design 2*

Redesign in Prototype Description (C)

____

____

____

Evidence (E)

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

Redesign: Structure and Function Explanation (R)

____

____

____

____

____

____

____

____

____

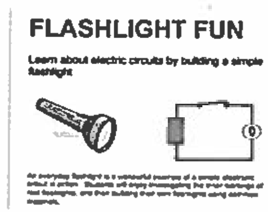
____

OUSD Science

1. What were the main structural features of your prototype? How did your team decide on these features?
2. How could you improve the design of your prototype?
3. What previous science knowledge or experiences did you use to design and build your prototype? Explain how your knowledge or previous experiences helped you to design and build your prototype.
4. What were some of the strengths of working together as engineers for the task? What are some areas that your team needs to improve when you work on the next task together?

Name:________________________ Date:________________ Per.________

Building a Circuit



I. What do I know?

Conductors are

____

Insulators are important because ______________

____

Examples of

Open circuit	Closed Circuit

II. Problem:

____

____

____

____

III. *Creating and testing*

Task: *Create a circuit and test to see which material will allow electricity to flow to light the bulb.*

Materials	Light	Insulator/Conductor
Rubber band		
Paper clip		
Aluminum		
Wire with plastic coating		
Thin copper wire		
Styrofoam		

IV. Summary/Conclusion

Inform which materials worked and which did not work. Explain using ***complete sentences****, as to why you think this happened.*

____

____

____

____

____

____

7.0.0 - Resource Sheet - Formative Assessment

Report to your Hardware Engineer Team

Directions:

You are a hardware engineer designing a circuit.
Write a report updating your team about your plan to build a circuit prototype with select materials.

In your report, include the following:

1. Explain how your team will work together to design a circuit prototype.
2. Describe main structural features for the circuit your team might include. Use evidence based on your previous experience(s).

Word Bank

design	collaboration	infer	function
model	evidence	reinforcement	circuit
prototype	observe	structure	engineering design process

Protocol for Assessing Collaboration and Teamwork

Setting Expectations
In teams, have students complete a brainstorm concept web describing characteristics and observable evidence of ***"collaboration***." As individuals, students will then answer the writing prompt, *"What evidence can we look for to prove our team is collaborating effectively?"*

Assessment
During an investigation or activity, the teacher will ask teams to stop and pause. During this time, teams will self assess their collaboration, and will discuss ways to improve. As a team, students will discuss and decide upon their score for each category and will place an "X" in the appropriate box and write down suggestions for improvement on the rubric. Then, teams will return to work, and the teacher will rotate around the class assessing teams for their final scores.

Collaboration and Teamwork Rubric Instructions

1. Cut and glue the rubric into your science notebook on page 5.
2. **Individually** circle the most important words in each box and create a title that explains the meaning of "4, 3, 2, 1."
3. **In your team**, share out your circled words and highlight the REALLY important words.
4. **In your notebook**, below the rubric, answer the following question: ***"What is collaboration?"*** (Use complete sentences).
5. As a team decide on titles for "4, 3, 2, 1."

Collaboration and Teamwork
Analytic Rubric

Category	4	3	2	1
Focused Completion of Task	Consistently and actively works towards the completion of team's goals and assigned work. Identifies changes when needed and encourages group action for change.	Completes task and assigned work. Needs some prompting to stay focused. Makes needed changes willingly when suggested by teacher.	Focuses on task only when prompted. Does not want to make needed changes. Relies on one or two teammates to do all the work.	Team is unfocused and has not completed the task in the time given. Teacher prompts result in zero change.
Consideration of Others	Shows sensitivity to the feelings and needs of others. The team values each other's ideas, knowledge, opinions, and skills through active listening. Everyone is encouraged to participate.	Shows and expresses sensitivity to the feelings and needs of others. Takes turns participating, but may not be actively listening and valuing other people's ideas.	Needs several reminders to be sensitive to other's feelings and needs. Teammates are talking, but not listening to each other. Other's ideas are not valued.	Teammates are insensitive to each other's feelings and needs and teacher reminders result in zero change.
Contribution of Knowledge and Ideas	Everyone actively and consistently contributes knowledge, opinions, and skills without having to be reminded.	Everyone contributes knowledge, opinions, and skills with some prompting.	Everyone contributes, but participation is imbalanced and requires many prompts.	Some teammates contributed zero knowledge, opinions, and skills.

Teammates: ____________________ ____________________ Period: __________

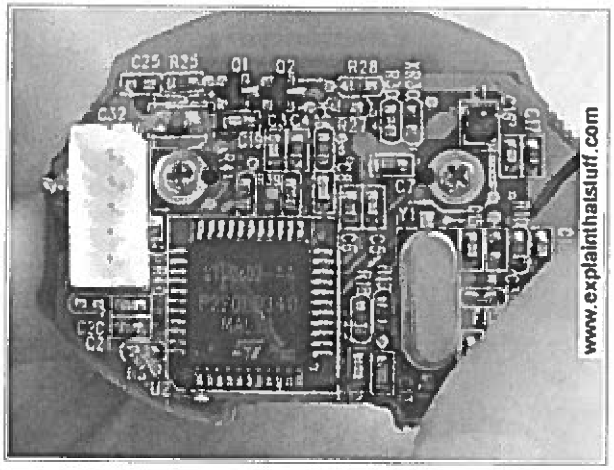
____________________ ____________________ Date: __________

Output Sheet: ***Collaboration and Teamwork Rubric***

Rubric Category	4	3	2	1
Focused Completion of Task Consistently and actively works towards the completion of team's goals and assigned work. Identifies changes when needed and encourages group action for change.				
Consideration of Others Shows sensitivity to the feelings and needs of others. The team values each other's ideas, knowledge, opinions, and skills through active listening. Everyone is encouraged to participate.				
Contribution of Knowledge and Ideas Everyone actively and consistently contributes knowledge, opinions, and skills without having to be reminded.				

Team Suggestions for Improvement:	Teacher Feedback:

Team Final Scores	
Focused Completion of Task	
Consideration of Others	
Contribution of Knowledge and Ideas	



Electronics

by Chris Woodford. *Last updated: November 27, 2017.*

They store your money. They monitor your heartbeat. They carry the sound of your voice into other people's homes. They bring airplanes into land and guide cars safely to their destination—they even fire off the airbags if we get into trouble. It's amazing to think just how many things "they" actually do. "They" are electrons: tiny particles within atoms that march around defined paths known as circuits carrying electrical energy. One of the greatest things people learned to do in the 20th century was to use electrons to control machines and process information. The electronics revolution, as this is known, accelerated the computer revolution and both these things have transformed many areas of our lives. But how exactly do nanoscopically small particles, far too small to see, achieve things that are so big and dramatic? Let's take a closer look and find out!

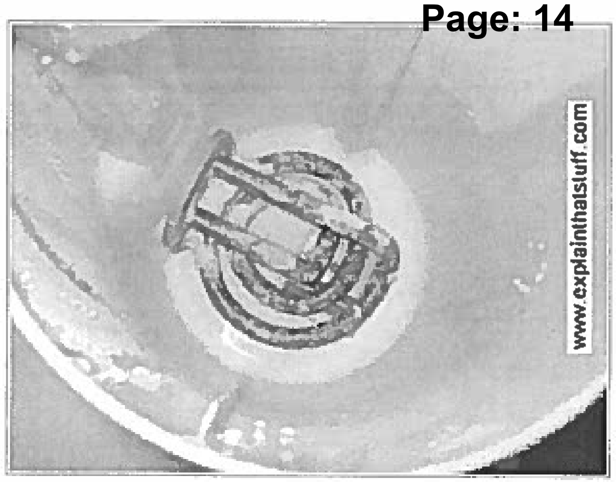
Photo: The compact, electronic circuit from a webcam.

What's the difference between electricity and electronics?

If you've read our article about electricity, you'll know it's a kind of energy—a very versatile kind of energy that we can make in all sorts of ways and use in many more. Electricity is all about making electromagnetic energy flow around a circuit so that it will drive something like an electric motor or a heating element, powering appliances such as electric cars, kettles, toasters, and lamps. Generally, electrical appliances need a great deal of energy to make them work so they use quite large (and often quite dangerous) electric currents.

Photo: The 2500-watt heating element inside this electric kettle operates on a current of about 10 amps. By contrast, electronic components use currents likely to be measured in fractions of milliamps (which are thousandths of amps). In other words, a typical electric appliance is likely to be using currents tens, hundreds, or thousands of times bigger than a typical electronic one.

Electronics is a much more subtle kind of electricity in which tiny electric currents (and, in theory, single electrons) are carefully directed around much more complex circuits to process signals (such as those that carry radio and television programs) or store and process information. Think of something like a microwave oven and it's easy to see the difference between ordinary electricity and electronics. In a microwave, electricity provides the power that generates high-energy waves that cook your food; electronics controls the electrical circuit that does the cooking.



Analog and digital electronics

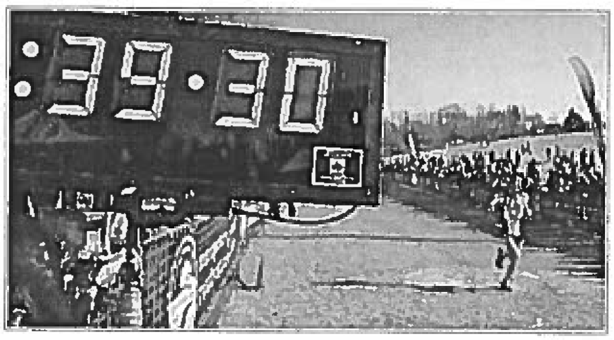


Photo: Digital technology: Large digital clocks like this are quick and easy for runners to read. Photo by Jhi L. Scott courtesy of US Navy.

There are two very different ways of storing information—known as analog and digital. It sounds like quite an abstract idea, but it's really very simple. Suppose you take an old-fashioned photograph of someone with a film camera. The camera captures light streaming in through the shutter at the front as a pattern of light and dark areas on chemically treated plastic. The scene you're photographing is converted into a kind of instant, chemical painting —an "analogy" of what you're looking at. That's why we say this is an analog way of storing information. But if you take a photograph of exactly the same scene with a digital camera, the camera stores a very different record. Instead of saving a recognizable pattern of light and dark, it converts the light and dark areas into numbers and stores those instead. Storing a numerical, coded version of something is known as digital.

Electronic equipment generally works on information in either analog or digital format. In an old-fashioned transistor radio, broadcast signals enter the radio's circuitry via the antenna sticking out of the case. These are analog signals: they are radio waves, traveling through the air from a distant radio transmitter, that vibrate up and down in a pattern that corresponds exactly to the words and music they carry. So loud rock music means bigger signals than quiet classical music. The radio keeps the signals in analog form as it receives them, boosts them, and turns them back into sounds you can hear. But in a modern digital radio, things happen in a different way. First, the signals travel in digital format—as coded numbers. When they arrive at your radio, the numbers are converted back into sound signals. It's a very different way of processing information and it has both advantages and disadvantages.

Generally, most modern forms of electronic equipment (including computers, cellphones, digital cameras, digital radios, hearing aids, and televisions) use digital electronics.

Electronic components

If you've ever looked down on a city from a skyscraper window, you'll have marveled at all the tiny little buildings beneath you and the streets linking them together in all sorts of intricate ways. Every building has a function and the streets, which allow people to travel from one part of a city to another or visit different buildings in turn, make all the buildings work together. The collection of buildings, the way they're arranged, and the many connections between them is what makes a vibrant city so much more than the sum of its individual parts.

The circuits inside pieces of electronic equipment are a bit like cities too: they're packed with components (similar to buildings) that do different jobs and the components are linked together by cables or printed metal connections (similar to streets). Unlike in a city, where virtually every building is unique and even two supposedly identical homes or office blocks may be subtly different, electronic circuits are built up from a small number of standard components. But, just like LEGO®, you can put these components together in an infinite number of different places so they do an infinite number of different jobs.

These are some of the most important components you'll encounter:

Resistors

These are the simplest components in any circuit. Their job is to restrict the flow of electrons and reduce the current or voltage flowing by converting electrical energy into heat. Resistors come in many different shapes and sizes. Variable resistors (also known as potentiometers) have a dial control on them so they change the amount of resistance when you turn them. Volume controls in audio equipment use variable resistors like these.

Read more in our main article about resistors.

Photo: A typical resistor on the circuit board from a radio.

Diodes

The electronic equivalents of one-way streets, diodes allow an electric current to flow through them in only one direction. They are also known as rectifiers. Diodes can be used to change alternating currents (ones flowing back and forth round a circuit, constantly swapping direction) into direct currents (ones that always flow in the same direction).

Read more in our main article about diodes.

Photo: Diodes look similar to resistors but work in a different way and do a completely different job. Unlike a resistor, which can be inserted into a circuit either way around, a diode has to be wired in the right direction (corresponding to the arrow on this circuit board).

Capacitors

These relatively simple components consist of two pieces of conducting material (such as metal) separated by a non-conducting (insulating) material called a dielectric. They are often used as timing devices, but they can transform electrical currents in other ways too. In a radio, one of the most important jobs, tuning into the station you want to listen to, is done by a capacitor.

Read more in our main article about capacitors.

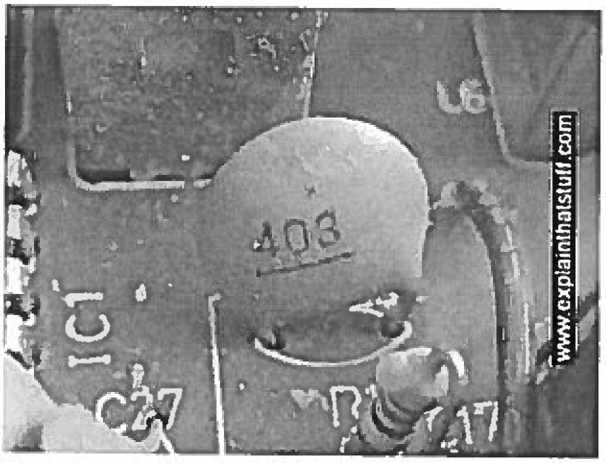


Photo: A small capacitor in a transistor radio circuit.

Transistors

Easily the most important components in computers, transistors can switch tiny electric currents on and off or amplify them (transform small electric currents into much larger ones). Transistors that work as switches act as the memories in computers, while transistors working as amplifiers boost the volume of sounds in hearing aids. When transistors are connected together, they make devices called logic gates that can carry out very basic forms of decision making. (Thyristors are a little bit like transistors, but work in a different way.)

Read more in our main article about transistors.

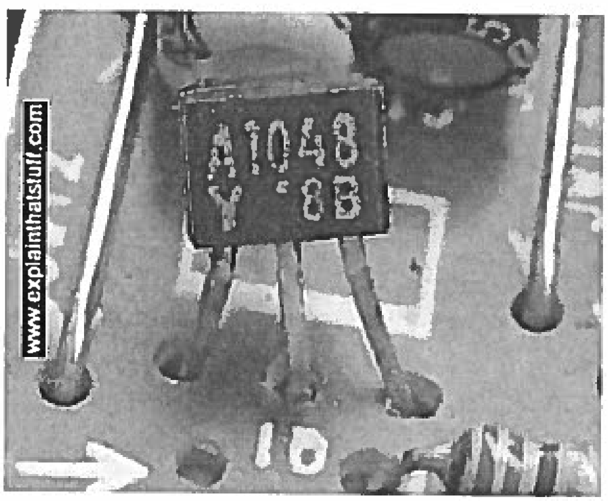


Photo: A typical field-effect transistor (FET) on an electronic circuit board.

Opto-electronic (optical electronic) components

There are various components that can turn light into electricity or vice-versa. Photocells (also known as photoelectric cells) generate tiny electric currents when light falls on them and they're used as "magic eye" beams in various types of sensing equipment, including some kinds of smoke detector. Light-emitting diodes (LEDs) work in the opposite way, converting small electric currents into light. LEDs are typically used on the instrument panels of stereo equipment. Liquid crystal displays (LCDs), such as those used in flatscreen LCD televisions and laptop computers, are more sophisticated examples of opto-electronics.

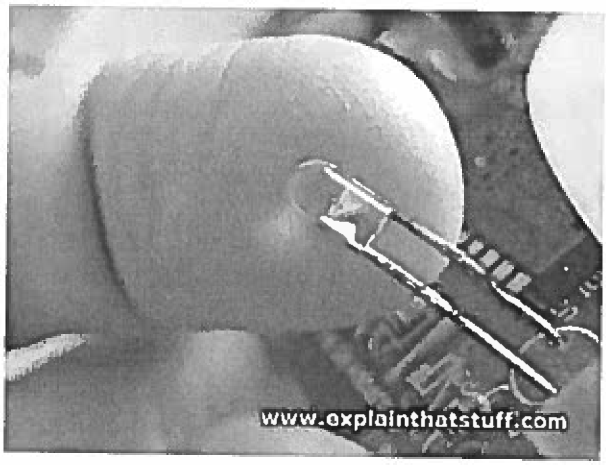


Photo: An LED mounted in an electronic circuit. This is one of the LEDs that makes red light inside an optical computer mouse.

Electronic components have something very important in common. Whatever job they do, they work by controlling the flow of electrons through their structure in a very precise way. Most of these components are made of solid pieces of partly conducting, partly insulating materials called semiconductors (described in more detail in our article about transistors). Because electronics involves understanding the precise mechanisms of how solids let electrons pass through them, it's sometimes known as solid-state physics. That's why you'll often see pieces of electronic equipment described as "solid-state."

Electronic circuits

The key to an electronic device is not just the components it contains, but the way they are arranged in circuits. The simplest possible circuit is a continuous loop connecting two components, like two beads fastened on the same necklace. Analog electronic appliances tend to have far simpler circuits than digital ones. A basic transistor radio might have a few dozen different components and a circuit board probably no bigger than the cover of a paperback book. But in something like a computer, which uses digital technology, circuits are much more dense and complex and include hundreds, thousands, or even millions of separate pathways. Generally speaking, the more complex the circuit, the more intricate the operations it can perform.

If you've experimented with simple electronics, you'll know that the easiest way to build a circuit is simply to connect components together with short lengths of copper cable. But the more components you have to connect, the harder this becomes. That's why electronics designers usually opt for a more systematic way of arranging components on what's called a circuit board. A basic circuit board is simply a rectangle of plastic with copper connecting tracks on one side and lots of holes drilled through it. You can easily connect components together by poking them through the holes and using the copper to link them together, removing bits of copper as necessary, and adding extra wires to make additional connections. This type of circuit board is often called "breadboard".

Electronic equipment that you buy in stores takes this idea a step further using circuit boards that are made automatically in factories. The exact layout of the circuit is printed chemically onto a plastic board, with all the copper tracks created automatically during the manufacturing process. Components are then simply pushed through pre-drilled holes and fastened into place with a kind of electrically conducting adhesive known as solder. A circuit manufactured in this way is known as a printed circuit board (PCB).

Photo: Soldering components into an electronic circuit. The smoke you can see comes from the solder melting and turning to a vapor. The blue plastic rectangle I'm soldering onto here is a typical printed circuit board—and you see various components sticking up from it, including a bunch of resistors at the front and a large integrated circuit at the top.

Although PCBs are a great advance on hand-wired circuit boards, they're still quite difficult to use when you need to connect hundreds, thousands, or even millions of components together. The reason early computers were so big, power hungry, slow, expensive, and unreliable is because their components were wired together manually in this old-fashioned way. In the late 1950s, however, engineers Jack Kilby and Robert Noyce independently developed a way of creating electronic components in miniature form on the surface of pieces of silicon. Using these integrated circuits, it rapidly became possible to squeeze hundreds, thousands, millions, and then hundreds of millions of miniaturized components onto chips of silicon about the size of a finger nail. That's how computers became smaller, cheaper, and much more reliable from the 1960s onward.

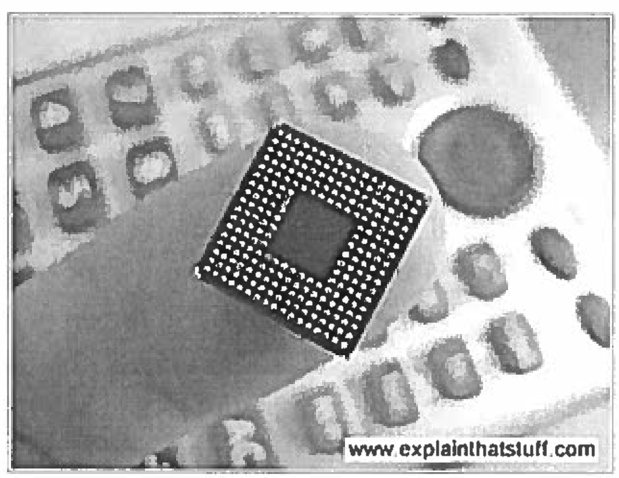


Photo: Miniaturization. There's more computing power in the processing chip resting on my finger here than you would have found in a room-sized computer from the 1940s!

Electronics around us

Electronics is now so pervasive that it's almost easier to think of things that don't use it than of things that do.

Entertainment was one of the first areas to benefit, with radio (and later television) both critically dependent on the arrival of electronic components. Although the telephone was invented before electronics was properly developed, modern telephone systems, cellphone networks, and the computers networks that the heart of the Internet all benefit from sophisticated, digital electronics.

Try to think of something you do that doesn't involve electronics and you may struggle. Your car engine probably has electronic circuits in it—and what about the GPS satellite navigation device that tells you where to go? Even the airbag in your steering wheel is triggered by an electronic circuit that detects when you need some extra protection.

Electronic equipment saves our lives in other ways too. Hospitals are packed with all kinds of electronic gadgets, from heart-rate monitors and ultrasound scanners to complex brain scanners and X-ray machines. Hearing aids were among the first gadgets to benefit from the development of tiny transistors in the mid-20th century, and ever-smaller integrated circuits have allowed hearing aids to become smaller and more powerful in the decades ever since.

Who'd have thought have electrons—just about the smallest things you could ever imagine—would change people's lives in so many important ways?

C.H.A.T. To The Text

C – **Circle** the **vocabulary** words that you don't know or that might be challenging for other students in your class

H – **Highlight** the **evidence** to support the author's claim

A – **Annotate** the Text. **Add comments**, questions, connections, A-Ha moments or summarizing statements in the margins of the text. Every time you highlight something, you must add an annotation!

T – **Talk** to the Text. Underline, label and explain any **Cross Cutting Concepts**. You may want to use different colors to help show different CCC's.

1. **Patterns:** Do you see any patterns in what you read to the real world or to other science topics?
2. **Cause and Effect:** Do you see variables that you could test? Does one variable cause an effect on the other variable?
3. **Scale, Proportion, and Quantity:** If you changed the variables to a different size, amount of time, or energy, would there be a proportional change to another variable?
4. **Systems and System Models:** Could you design a system or use a current system to predict changes or design a solution to a current societal need or want?
5. **Energy and Matter:** If you were to track how the energy transferred or how the matter changed, could it help you understand how a system works or make any new conclusions?
6. **Structure and Function:** Can you see any way that the structures are shaped relate to the job they have to do or the way they behave?
7. **Stability and Change:** Can you see a way that a system is working to reach stability? Or, can you see how changes to a system can affect the stability of a system?

1. Annotate title
2. Annotate pictures
3. # paragraphs

Read through #1

4. Circle vocab
5. Add definitions/synonyms based on context for circled vocab

Read through #2

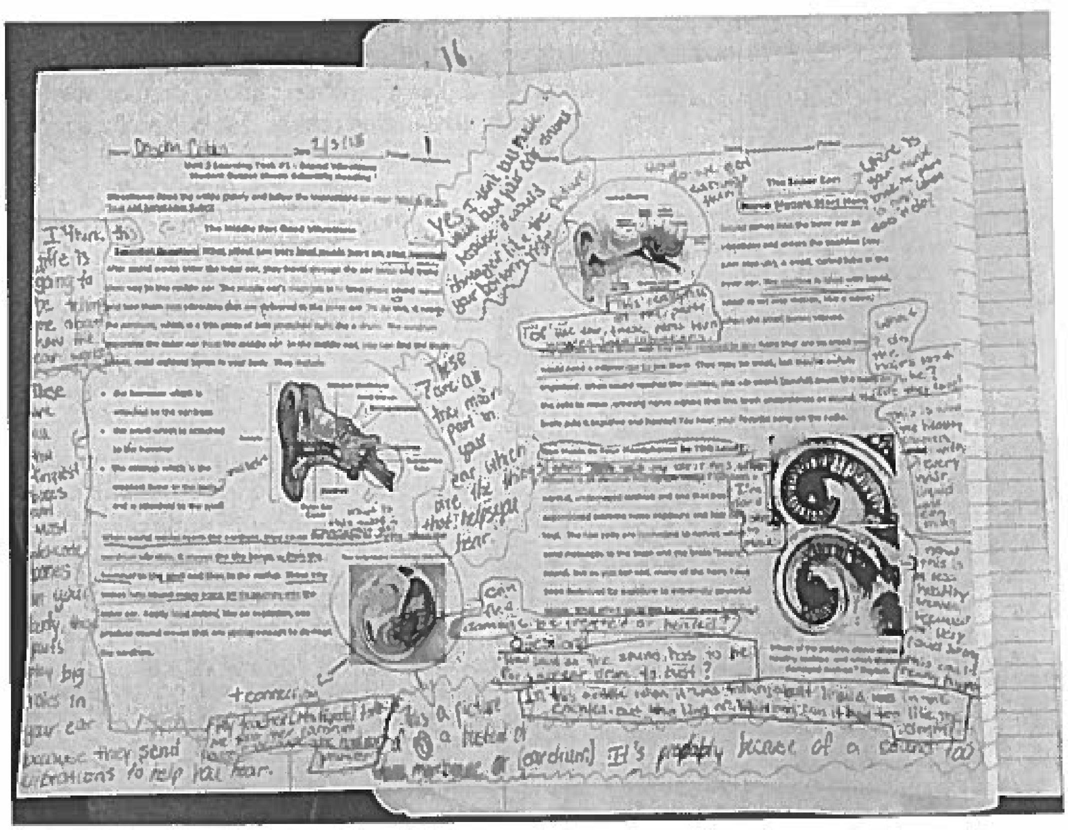
6. Highlight important details of article

Read through #3

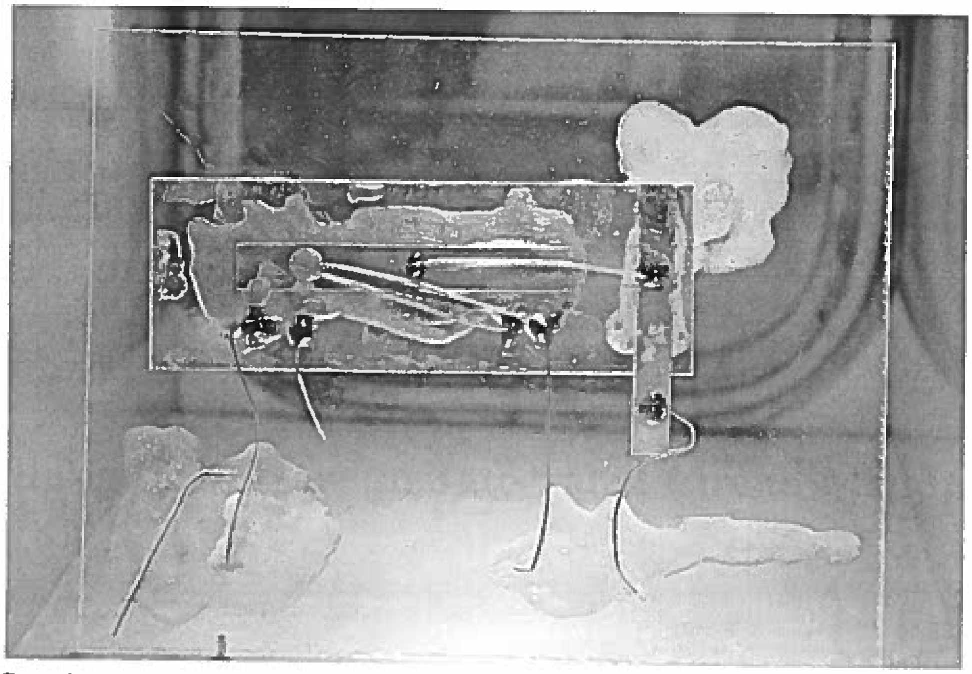
7. Add annotation for ALL highlights (questions you have about it, why is it important, what does it mean?)
8. Underline the main sentence(s) that let you know what the cross cutting concept is and put CC: (and the concept it is) next to it

"CHAT To The Text" and Annotating List Rubric

TASK	5	4	3	2	1
Annotate the Title Explain what you know or want to know about the subject					
Annotate Pictures Explain drawings, pictures, or graphs in your own words					
Vocabulary Circle vocabulary words and words you do not know Add definitions using context clues, notes, or class discussions					
Highlight Evidence to support or refute the author's claim.					
Annotate Highlighted Passages With: Questions that pop up for you as you read. <u>OR</u> Connections between the reading and your self, the world or something else you've read.					
Underline and Identify Cross Cutting Concepts					



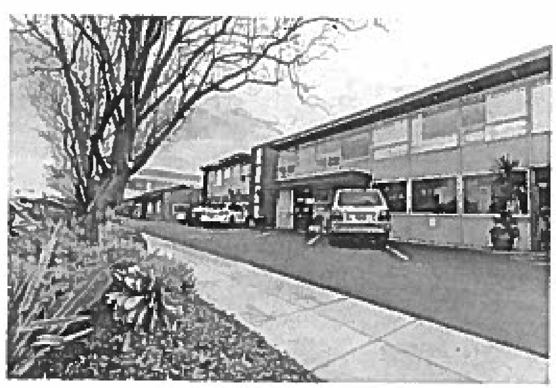
A Very Small Big Deal: How the Integrated Circuit Made Silicon Valley



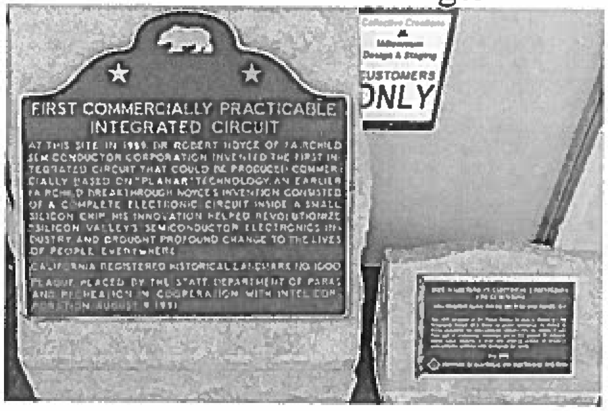
Replica of first integrated circuit by Jack Kilby. Photo: Florian Schäffer CC BY-SA 4.0

The integrated circuit might not inspire the same level of excitement as other tech breakthroughs, such as Facebook or the iPhone, but the impact of its invention was just as far-reaching, if not more so. You don't need an engineering degree to understand how it changed everyday life. In fact, if you're reading this on a smartphone, tablet, or laptop, you're benefiting from the integrated circuit.

The first commercially viable integrated circuit was invented in Silicon Valley and was fundamental to both naming the region and making it today's powerhouse of technical invention. Two plaques at the entrance to the former site of the Fairchild Semiconductor building in Palo Alto, California pay homage to the circuit's significance.



Former Fairchild Semiconductor building at 844 Charleston Road, Palo Alto, California. The historical markers are to the right of the door shown in the center of the photo. Photo: Garrick Ramirez/Mobile Ranger



Closeup of the two historical markers at the right of the door in the center of the photo. Photo: Garrick Ramirez/Mobile Ranger

OK, But What Is an Integrated Circuit?

An integrated circuit is an interconnected series of electronic components that are fitted onto a plate the size of a fingernail. It's also referred to by the more familiar term, the *microchip*. Integrated circuits are at the heart of most electronics. They perform the core functions of everyday devices, such as smartphones, cars, and ATMs. A *microprocessor*, the virtual brain inside a computer, is one example of an integrated circuit.

The introduction of the integrated circuit was revolutionary because it made both personal computing and handheld electronics possible. Before integrated circuits, computers filled rooms that resembled a digital Dr. Frankenstein's lab. For the first half of the 20th century, most electronics functioned on bulky vacuum tubes until the smaller and more efficient transistor was invented. The shift to transistors shrunk circuit boards significantly but not enough to make something like a handheld calculator possible. That all changed with the integrated circuit.

Robert Noyce with Motherboard, 1959. Photo: Intel Free Press CC BY SA 2.0

The Revolution Began with the Traitorous Eight

The story starts with the Traitorous Eight. What sounds like the title of a Quentin Tarantino flick refers instead to eight employees of Shockley Semiconductor Laboratory in Mountain View, California who fled to form their own semiconductor company in 1957. Word on the street was that owner William Shockley, co-inventor of the transistor, was a genius but a less-than-personable boss. The eight men christened their nascent company Fairchild Semiconductor and formalized the partnership by adding their signatures to a set of newly minted one dollar bills.

The Fairchild/Shockley 8, who left the lab of Nobel Prize winner William Shockey to form Silicon Valley's first start-up, Fairchild Semiconductor, 1960. From left to right: Gordon Moore, C. Sheldon Roberts, Eugene Kleiner, Robert Noyce, Victor Grinich, Julius Blank, Jean Hoerni, and Jay Last. Photo: Wayne Miller © Magnumphotos.com, used with permission

It was at Fairchild that the current model for the microchip was invented. Robert Noyce, one of the Traitorous Eight, created what was referred to as a *monolithic* integrated circuit. Rather than a traditional circuit, where individual components — transistors, resistors, and diodes — sat atop a large plate, linked by wires, Noyce's integrated circuit was one self-contained plate. Using a semiconductor, a substance of exceptional insulation and conductivity, the components were fabricated from and within the plate itself. This enabled the circuit to be much smaller and much faster. For his integrated circuit, Noyce used silicon, the primary element in sand and the material still used to produce microchips. It's also the substance that eventually redefined the Santa Clara Valley.

Silicon Proves More Fruitful Than Peaches

In the early 20th century, the Santa Clara Valley was blanketed in fruit orchards that supplied the nation with most of its apricots, prunes, and peaches. Long before Apple and

Google, the big names in the valley were Del Monte and Sunsweet. But after the rise of Fairchild, the number of semiconductor manufacturers began to proliferate. Many of those companies were formed by former Fairchild employees.

Prune Orchard Near Santa Clara, California. Photo: Oregon State University Special Collections & Archives

So influential was Fairchild that employees who left to form other companies were dubbed The Fairchildren. Noyce and his associate Gordon Moore eventually left Fairchild to start Intel, which later developed the first commercially viable microprocessor. By 1971, the number of semiconductor manufacturers in the Santa Clara Valley had grown so prevalent that journalist Don Hoefler referred to the region as "Silicon Valley USA," and the name stuck. Noyce was even called "The Mayor of Silicon Valley."

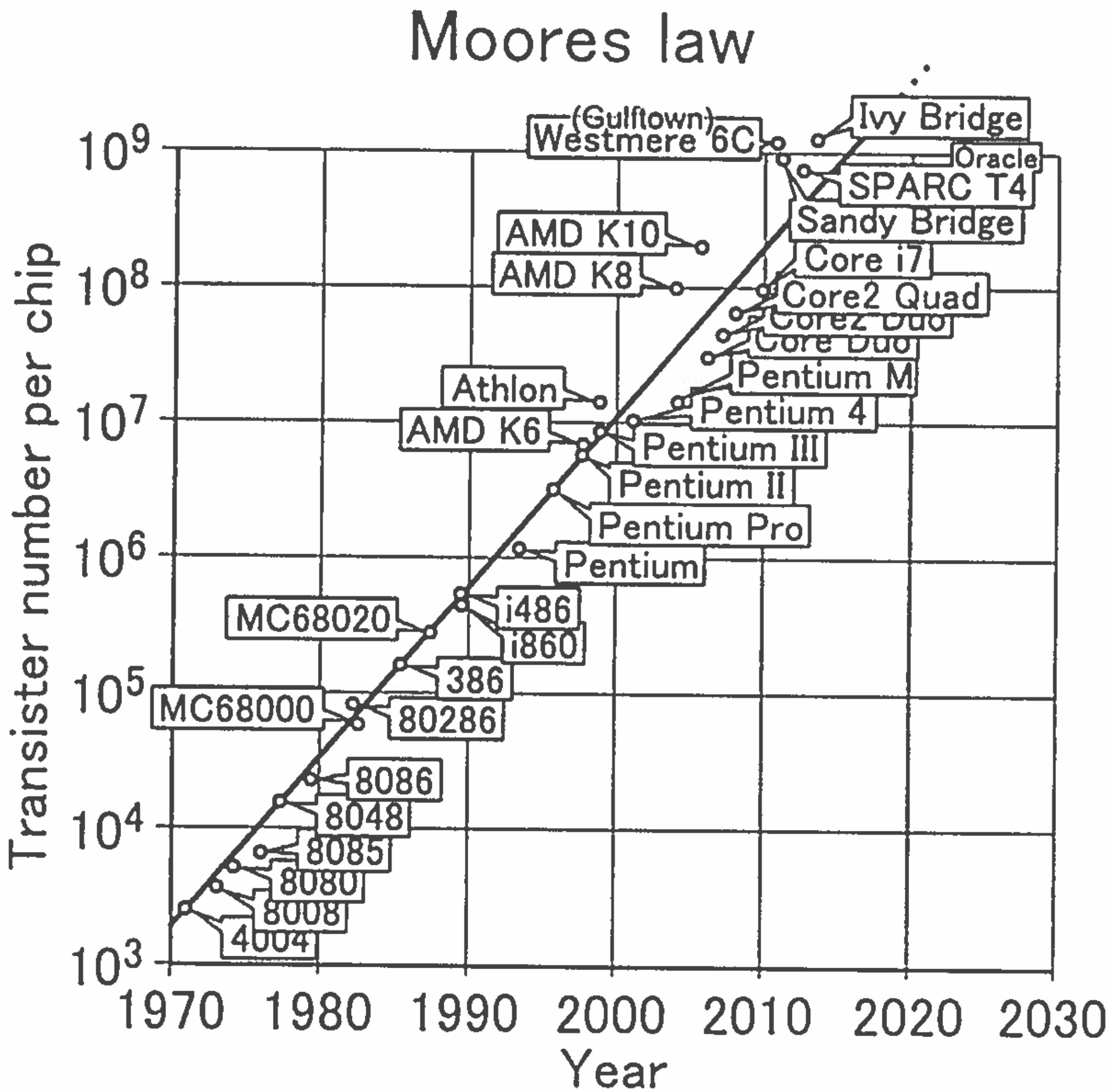
The Nobel Prize Goes to Who?

The historical markers at the entrance of the former Fairchild Building in Palo Alto commemorate Noyce's groundbreaking feat. But the real credit that counts for the invention of the integrated circuit, which won the Nobel Prize in Physics in 2000 for "basic work on information and communication technology," went to Jack Kilby, not Robert Noyce.

There's a story behind that, too, of course: In 1958, roughly six months before Noyce's discovery, Kilby invented the first integrated circuit when he was a new employee of Dallas-based Texas Instruments. But due to vulnerable wiring and the use of germanium as a semiconductor, Kilby's circuit was judged commercially unviable. Fairchild and Texas Instruments duked it out for years over the claim to the technology but finally settled upon Kilby and Noyce as co-inventors. Kilby took home the part of the 2000 Nobel Prize relating to integrated circuits, but Kilby did mention Noyce in his acceptance speech.

So Much Moore Than Before

Although Noyce's pioneering model is still used today, the capacity of microchips has grown exponentially. In 1965, Noyce's colleague, Gordon Moore, famously predicted that the number of transistors and corresponding processing power in a circuit would double roughly every year for 10 years. In 1975 he revised it to every two years. Although Moore made the prediction partly to encourage more sales of Fairchild Semiconductor chips, the engineers at Fairchild made it a goal to make sure Moore was right.



Moore's Law says that the number of transistors that can fit into a dense integrated circuit doubles approximately every two years, which doubles the processing capacity. It is named after a prediction by Gordon E. Moore, co-founder of Fairchild Semiconductor and Intel. The transistor numbers trend chart shows major central processing units (CPUs) 1970 – 2011. Graph: shigeru23 CC BY SA 3.0

Moore's prediction, which came to be known as Moore's Law, was prescient well beyond a few decades. In 1959, Noyce's circuit contained one transistor. Today, microchips contain hundreds of millions.

7.0.S Task Card: Building a Flashlight (Print 2 copies and place in plastic sleeves)

Guiding Question: How can failure lead to innovation?

Introduction
Have you ever used a flashlight? Have you ever wondered what the engineers needed to think about in order to build a device that shines light? Throughout the year you will be asked to think and work like an engineer to design and build different types of things to solve a specific problem.

Task: Build a flashlight prototype that meets the needs of your client and develop a model tracking the flow of energy in your prototype.

Time: 47-minutes

Materials: (per group) • 2 - D batteries • 2 - 5" piece of copper insulated wire with ends stripped • 1- toilet paper roll • 1 - light bulb • 2 - brass fastener	• 1 - 1" x 3" cardboard strip • 1 - paper clip • 1 - 5" of masking tape • additional supplies for constraints i.e. different size or amount of batteries, wires, light bulbs, cups • Client's constraint cards

Procedure:

1. Use the Quiet Brainstorm & Academic Discussion Scaffolds to create a model of a flashlight given your client's specific constraints (20-minutes)
2. Building a Prototype (15-minutes)
3. Prototype Analysis (5-minutes)
    a. As a class, record observations in the data table and analyze each prototype.

Flashlight Prototype Evaluation Criteria	
Materials	The materials you use is based on your client's constraints
Test	Does the prototype meet the needs of your client?

Reflection: (10-minutes)

Teamwork • Complete the Collaboration and Teamwork Rubric. • As a team, be prepared to share your team's thinking and decision-making process.

Individual Reflective Questions

Answer the following questions individually in your notebook.

1. What were the main structural features of your prototype? How did your team decide on these features?
2. How could you improve the design of your prototype?
3. What previous science knowledge or experiences did you use to design and build your prototype? Explain how your knowledge or previous experiences helped you to design and build your prototype.
4. What were some of the strengths of working together as engineers for the task? What are some areas that your team needs to improve when you work on the next task together?

Flashlight Prototype Redesign Graphic Organizer

Name: ______________________ Period: ____ Date: __________

Design 1	***Design 2***

Redesign in Prototype Description (C)

____

____

____

Evidence (E)

1. ______________________

____

2. ______________________

____

3. ______________________

____

Redesign: Structure and Function Explanation (R)

____

____

____

____

____

____

____

____

____

____

7.0.0 - Resource Sheet - Formative Assessment

Report to your Hardware Engineer Team

Directions:
You are a hardware engineer designing a flashlight light that meets the needs of your client.
Write a report updating your team about your plan to build a flashlight prototype.

In your report, include the following:

1. Explain how your team will work together to design the flashlight prototype.
2. Describe main structural features for the flashlight your team might include. Use evidence based on your previous experience(s).

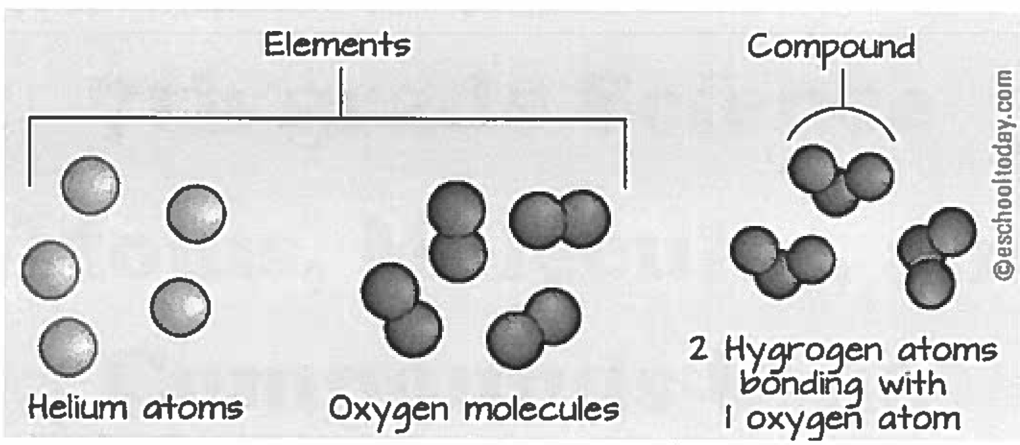
Word Bank

design	collaboration	infer	function
model	evidence	reinforcement	circuit
prototype	observe	structure	engineering design process

Lathrop Intermediate

7th grade Science

Atoms, Molecules, and Compounds Unit

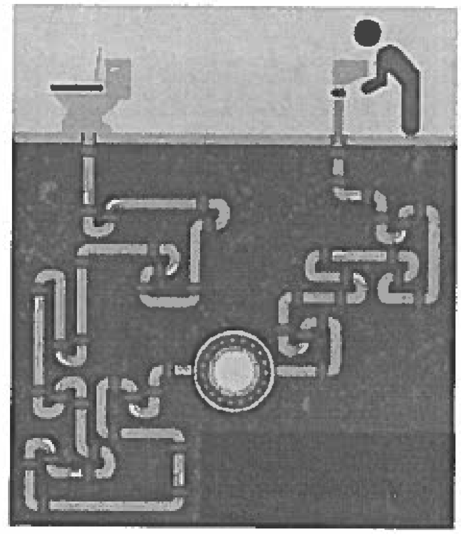


TASK PROBLEM:

Develop a model that shows how wastewater is treated so that it can be reused as a drinkable source of water.

Focus Question: How are scientists cleaning water to address California's drought?

A sign from wetter times warns people not to dive from a bridge over the Kern river. (David McNew / Getty Images)



From Toilet to Tap illustration (Jody Collins).

Your model will:

- ❑ Show only the <u>1st TWO</u> stages (microfiltration and reverse osmosis)
- ❑ Show water as individual molecules made up of atoms
- ❑ Include other substances shown as molecules that are filtered out of water
- ❑ Show what substances are collected during the different stages of filtration
- ❑ Demonstrate relative sizes of the different molecules and atoms
- ❑ Show how different stages filter out progressively smaller particles
- ❑ Show how a "mystery" molecule will move through the stages in their model

Include the following common substances in wastewater to filter out:

- water (H_2O)
- nitrate (NO_3)
- bacteria, like E. Coli
- viruses
- hair
- parts of salt (Na and Cl)
- food, like rice
- protozoa, like amoeba
- carbon dioxide (CO_2)
- sand
- toilet paper

"Mystery" Molecule addition:

A mystery molecule is discovered in the wastewater that is <u>SMALLER</u> than the water molecule. Describe how this molecule will move through the stages of your model.

to 1.0

• Draw a model of how you think a water filter works.

7.1.0- Resource

Drought is making treated wastewater a tastier option

Focus Question: How are scientists cleaning water to address California's drought?

Directions: Read and annotate the text below.

By Los Angeles Times, adapted by Newsela staff June 3, 2015

LOS ANGELES, Calif. — Experts say there is an effective way to help California deal with its long-running drought. However, there is one big problem with their solution — the "yuck factor." For a fourth straight year, California's drought has been shrinking the state's water supply. In response, water managers are pushing for something known as **direct potable reuse**. Direct potable reuse is a system that makes use of wastewater, much of it from toilets (see Figure 1). The idea is to purify the sewage so it can be used as drinking water. The idea of drinking "toilet water" makes some people gag. However, the process has been used in Namibia in Africa and drought-stricken cities, including Big Spring and Wichita Falls in Texas, and San Diego in California.

Time Might Be Ripe For "Toilet To Tap"

In other cities in California, however, such plans have run into heavy opposition. In 2000, opponents of a proposed reuse program in Los Angeles came up with the mocking phrase "toilet to tap." Their efforts to stop the program were ultimately successful. Still, supporters of the process are now pushing the idea again. They say the time has finally come for Californians to accept direct potable reuse as a partial solution to their growing water problem. With California Governor Jerry Brown ordering a 25-percent cut in water use in some areas, the solution makes sense, they say.

It particularly makes sense, they argue, for large coastal cities such as Los Angeles, that flush hundreds of billions of gallons of treated sewage into the Pacific Ocean each year. They could instead capture that wastewater, clean it and turn it into drinking water, supporters of reuse say. "That water is discharged into the ocean and lost forever," said Tim Quinn, director of the Association of California Water Agencies. "Yet it's probably the single largest source of water supply for California over the next quarter-century."

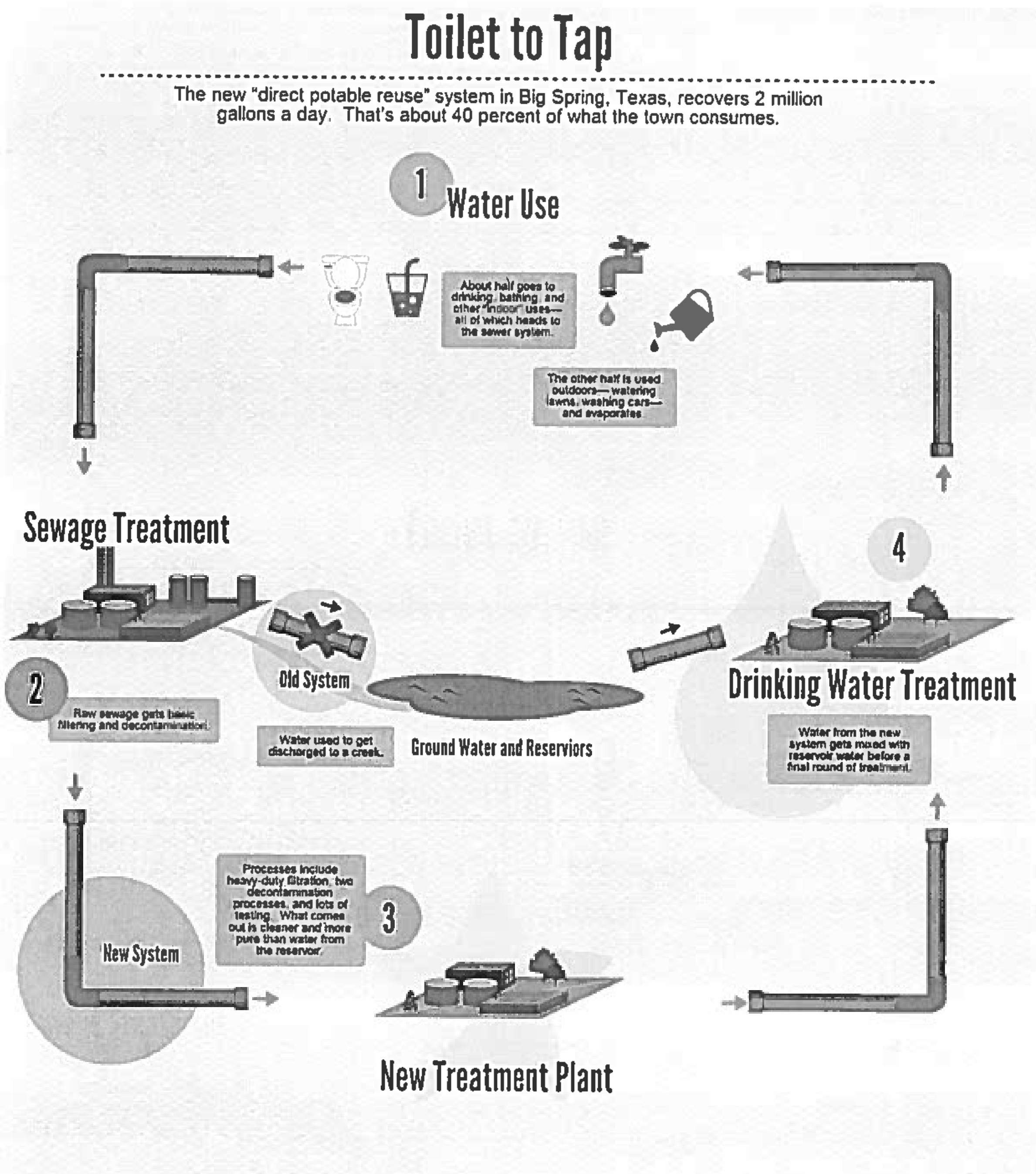


Figure 1. Diagram showing how a direct potable reuse system works in Big Spring, Texas. Taken from marketplace.org

Drought Is Changing Attitudes

California's severe drought may finally have changed long-held attitudes on potable reuse. Recently, a leader in the effort to stop the earlier Los Angeles project said he might consider a new plan. "You know, toilet to tap might be the only answer at this point," said activist Donald Schultz. "I don't support it, but we're running out of options. In fact, we may have already run out of options." Supporters of potable reuse insist that the public's distaste for the idea is based on ignorance. They note that more than 200 wastewater treatment plants already pour sewage into the Colorado River. The river is a primary source of drinking water for Southern California.

Wastewater Ends Up Cleaner Than Most Bottled Waters

In potable reuse systems, sewage is cleaned numerous times and very thoroughly. Look at Figure 2. First, the water is passed through a microfilter that blocks anything larger than 1/300th the thickness of a human hair. Next, it undergoes even finer filtering through a process called reverse osmosis: water is forced through a membrane that blocks fertilizers, drug compounds, viruses and salts. In the third step, ultraviolet light and hydrogen peroxide are used to break down any disease-causing bacteria that escaped the first two steps.

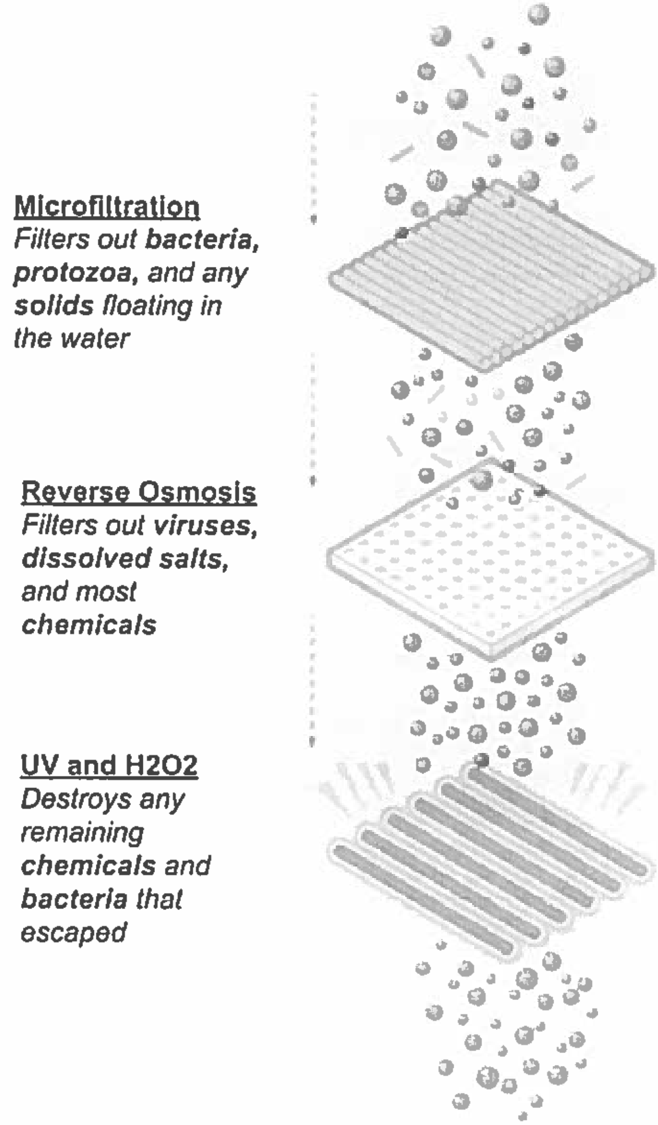


Figure 2.The three stages of the **Direct Potable Reuse process.** Text and image adapted from trojantechnologies.com

The result is a purified liquid that is cleaner than most bottled waters, supporters say. However, it is still sent to a traditional water treatment plant afterward. There it is blended with other sources of water, processed and pumped to homes.

Supporters of potable reuse say opposition is mostly driven by the so-called yuck factor. However, opponents say they have a variety of other reasons for their resistance, including cost and other unknown long-term effects.

Adapted from NewsELA

TDQ Wastewater Reading

1. Define microfiltration

2. What happens to the substances in wastewater during microfiltration?

3. What is the wastewater made of IMMEDIATELY AFTER microfiltration?

4. Define reverse osmosis

5. What happens to the substances in wastewater during reverse osmosis?

6. What is the wastewater made of AFTER reverse osmosis?

7. What other information from the text about the direct potable reuse process would be helpful in revising your model?

ENGAGE Coffee Filter Task Card
In a Time of Drought

Focus Question:
What kinds of substances do coffee filters separate from water?

Materials for Each Group
- Water
- 6 plastic cups
- 1 Spoon
- 3 coffee filters
- Measuring spoon (1 teaspoon)
- Measuring cup (1/2 cup)
- sand
- sugar
- table salt
- Marker

Preparing for Data Collection
Record the data table below into your notebook.

Substance	Observations of substance before	Observations of liquid and filter after	Went THROUGH the filter (Yes/No)
Sand			
Sugar			
Salt			

Procedures
1. Get 6 plastic cups. Label the cups the following with the marker:
   - Sand
   - Sugar
   - Salt
   - Filtered Sand
   - Filtered Sugar
   - Filtered Salt
2. Place the 3 cups labeled "Filtered" off to the side. You will use them later.
3. Place 1 tsp of each substance (sand, salt, sugar) into the appropriately labeled cup.
4. Observe each and note differences between the size of each grain/crystal. ***Note: Try crushing some of the grains/crystals to see how small you can get them.***
5. Get the "Sand" cup and pour in 1/2 cup of water. Mix them together with the spoon. Clean the spoon.
6. Place one coffee filter into the "Filtered Sand" cup so that the liquid when poured HAS to go through the filter.
7. Take the mixture in the "Sand" cup and pour it SLOWLY through the filter into the "Filtered Sand" cup. Make sure the liquid in the filter does not overflow or rip the filter.
8. Record observations of the liquid and anything left in the filter from the mixture and if the mixture went completely through.
9. Repeat steps 5-8 with the sugar and salt using the appropriately labeled cups.

Discussion Questions
1. Which substances made it through the filter? Which substances were stuck on the filter?
2. How were the substances that made it through DIFFERENT FROM the substances that got stuck in the filter?
3. What happened to the water in each of the mixtures? Why did the water go through the filter?

Coffee Filter Data Table

Focus Question: *What kinds of substances do coffee filters separate from water?*

Data Collection

Substance	Observations of substance before	Observations of liquid and filter after	Went THROUGH the filter (Yes/No)
Sand			
Sugar			
Salt			

Coffee Filter Lab Discussion

1. Which substances made it through the filter?

2. Which substances were stuck on the filter?

3. How were the substances that made it through DIFFERENT FROM the substances that got stuck in the filter?

4. What happened to the water in each of the mixtures?

5. Why did the water go through the filter?

CARD SORT Task Card
In a Time of Drought

TASK PROBLEM:
Develop a model that shows how wastewater is treated so that it can be reused as a drinkable source of water.

Focus Question: How are scientists cleaning water to address California's drought?

Directions:

1. Use the the following resources to sort the Substances in Wastewater cards by size, going from smallest to largest.
    a. **Periodic table showing relative size** - an arrangement of the chemical elements that make up all living and nonliving matter
    b. **The Scale of the Universe 2 animation** - a tool to show the relative size of different objects, including microscopic ones. Go to http://htwins.net/scale/ Press **start** to begin.

Use the scroll bar to zoom in and out. Click on objects to learn more.

2. Record the the name of each common substance in wastewater, in order from smallest to largest, in your notebook. Label the **largest** object and **smallest** object.

Some common substances in wastewater are:

- water (H_2O)
- nitrate (NO_3)
- bacteria, like E. Coli
- viruses
- hair
- parts of salt (Na and Cl)
- food, like rice
- carbon dioxide (CO_2)
- sand
- toilet paper
- protozoa, like amoeba

The Periodic Table of the Elements, in Pictures

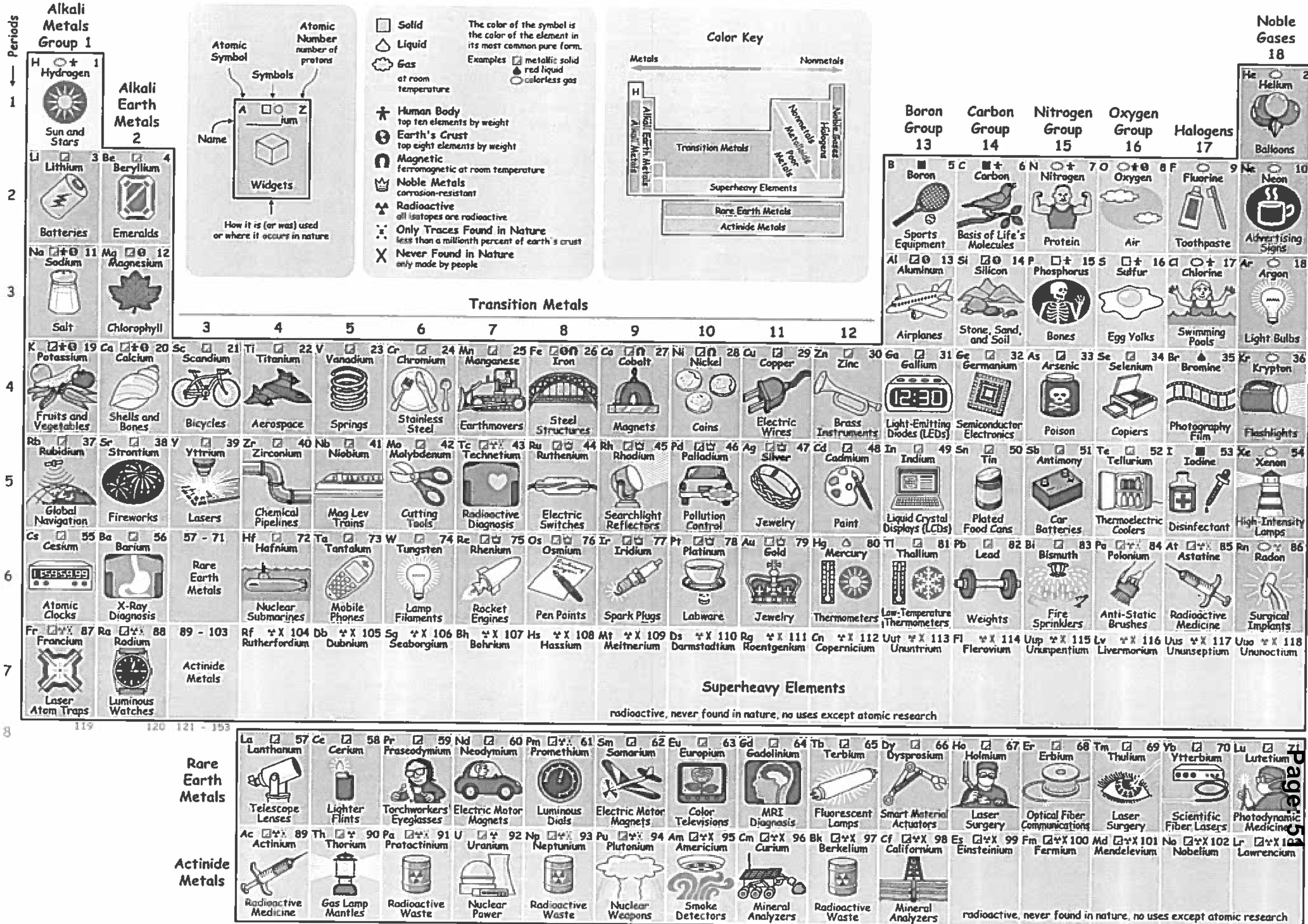
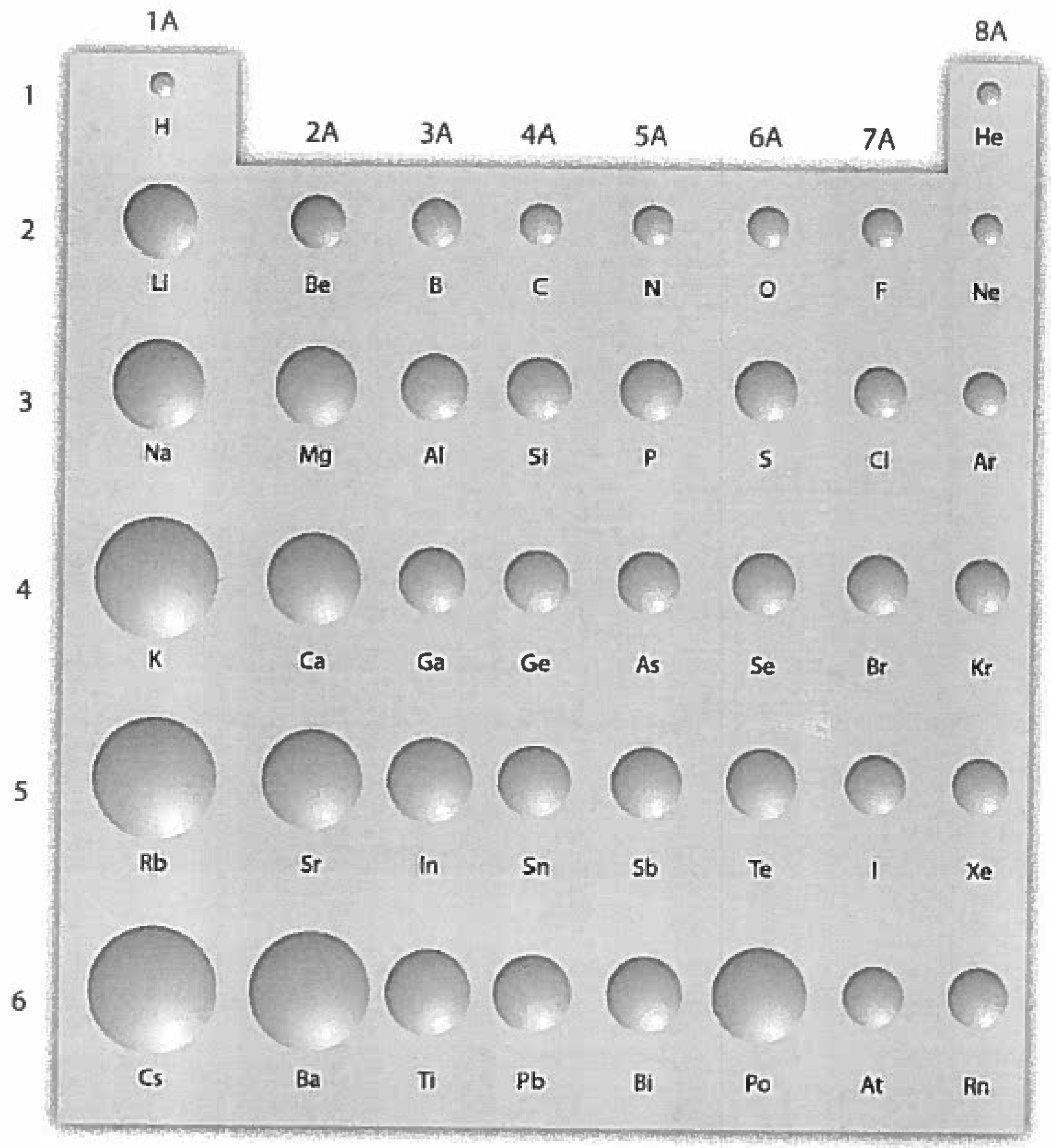


Figure 2.11 Trends on the Periodic Table



The relative sizes of the atoms show several trends with regard to the structure of the periodic table. Atoms become larger going down a column and smaller going across a period.

7.1.1 Task Card: Application

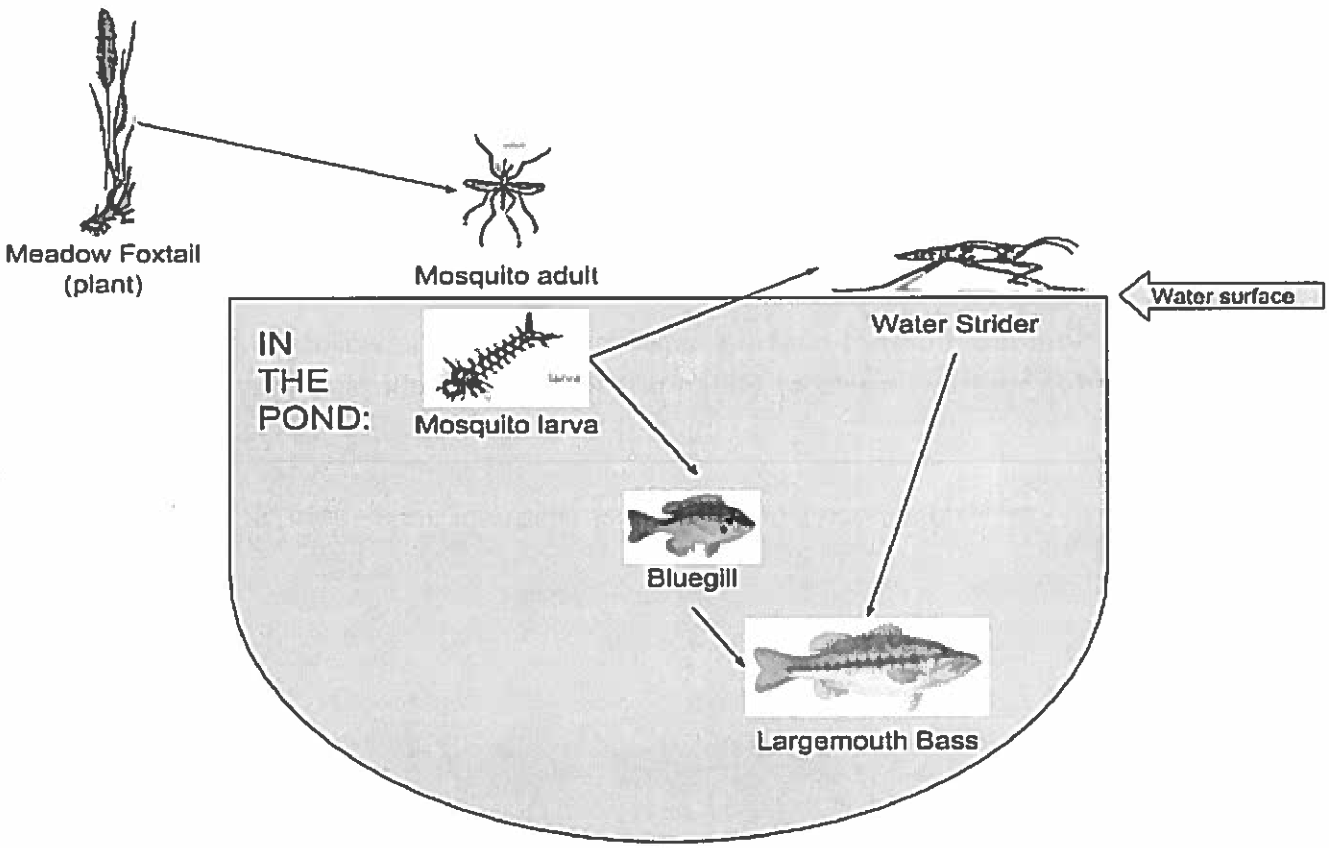
Guiding Question: What properties of water support life in a pond?

__Task:__

Using what you know about water and its unique properties, explain how the properties of water support life in the pond ecosystem below.

Include __at least two__ of the following properties of water: **surface tension, density of solid water compared to liquid water, capillary action, or the ability to dissolve other substances (solubility)** in your explanation.

Below is a food web that models the interactions in this pond's ecosystem.



In addition, observe how the pond changes throughout different seasons:

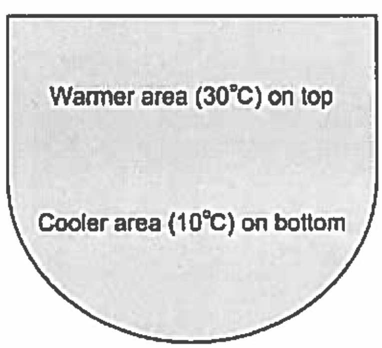


Figure 1. Pond in summer

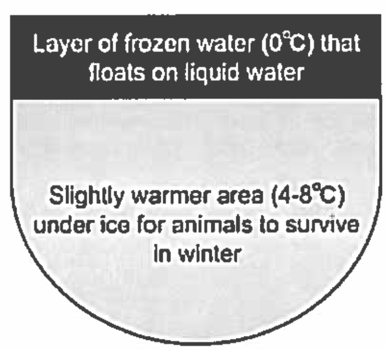


Figure 2. Pond in winter

7.1.1 Task Card: Application

Guiding Question: What properties of water support life in a pond?

Your explanation should:

- ❑ Describe at least two properties of water that support the pond ecosystem
- ❑ Cite evidence from the reading(s) and/or seasonal pond diagram
- ❑ Include evidence that is appropriate and sufficient to prove your argument
- ❑ Explain how a property of water helps a specific organism to survive (for 2 properties of water)
- ❑ Explain how the interactions of water at the molecular level enable it to possess different properties (surface tension, solubility, density, or climbing action)
- ❑ Connect the evidence to the claim

<u>7.1.1 Task Card</u>: Properties of Water

Guiding Question: What properties of water support life in a pond?

<u>Task</u>: You and your group members will visit four stations to explore and make sense of specific water properties. Once you have completed all four stations, clean up your area, compete the Collaboration Rubric to assess your group work, and respond to the Discussion Questions in your notebook.

<u>What to write down for each station:</u>

1. Record the number of the station, the **property being tested, the property's definition,** and the data collected from the station exploration (i.e. what you observe or record)
2. Leave enough space on your Data Table to record information / observations

Station #	Property Being Tested & Possible Definition	Data (Qualitative observations and quantitative)
1		
2		
3		
4		

<u>Collaboration Rubric:</u>

Category	3	2	1	0
Focused Completion of Task	Consistently and actively works towards the completion of team's goals and assigned work. Identifies changes when needed and encourages group action for change.	Completes task and assigned work. Needs some prompting to stay focused. Makes needed changes willingly when suggested by teacher.	Focuses on task only when prompted. Does not want to make needed changes. Relies on one or two teammates to do all the work.	Team is unfocused and has not completed the task in the time given. Teacher prompts result in zero change.
Consideration of Others	Shows sensitivity to the feelings and needs of others. The team values each other's ideas, knowledge, opinions, and skills through active listening. Everyone is encouraged to participate.	Shows and expresses sensitivity to the feelings and needs of others. Takes turns participating, but may not be actively listening and valuing other people's ideas.	Needs several reminders to be sensitive to other's feelings and needs. Teammates are talking, but not listening to each other. Others' ideas are not valued.	Teammates are insensitive to each other's feelings and needs and teacher reminders result in zero change.
Contribution of Knowledge and Ideas	Everyone actively and consistently contributes knowledge, opinions, and skills without having to be reminded.	Everyone contributes knowledge, opinions, and skills with some prompting.	Everyone contributes, but participation is imbalanced and requires many prompts.	Some teammates contributed zero knowledge, opinions, and skills.

STATION 1: Solubility

Task Steps:

1. Record the property being tested (solubility) in your Data Table.
2. Pour 100mL of water into the **empty** beaker.
3. Put **1 tsp** of salt in the beaker with water.
4. Using the spoon labeled "water," stir vigorously for 1 minute. Try not to spill!
5. *Record your observations in the Data Table in your science notebook.*
6. Observe the beaker with oil (100 ml). This beaker already has 1 tsp of salt poured inside.
7. Using the spoon labeled "oil," stir the beaker with salt and oil vigorously for 1 minute.
8. *Record your observations in the Data Table in your science notebook.*
9. Clean up the station / station materials.
    - Leave the oil and salt as you found it. Pour the beaker of salty water into the container labeled "saltwater." Reset the station as you found it…beakers, spoons, salt, etc…
10. As a group, respond to the **Discussion Questions** (below) in your science notebook.

Discussion Questions:

- 1A. Which liquid is better at dissolving the salt (water or oil)?
- 1B. Why might this be?
- 1C. Using this exploration, construct a definition for the term "solubility."

STATION 2: Surface Tension and Cohesion

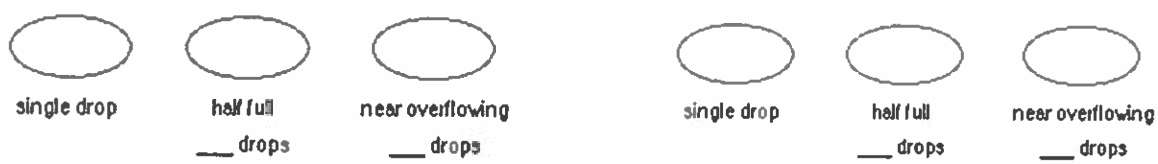
Part A - Surface Tension and Cohesion:

Guiding Question: Will the penny hold more drops of water or alcohol before it overflows?

Task Steps:

1. Label the properties of water being explored (surface tension and cohesion) on your Data Table.
2. In your notebook, under your data table, predict whether a penny will hold more drops of **water** or **alcohol.**
    a. Have each member **share out** and **explain** their predictions to the group.
    b. Record each group member's prediction in your science notebook.
3. Under your prediction, set up a diagram (like the one below). You will add to this diagram throughout the exploration.

Water **Alcohol**



4. Fill the dropper labeled "water" with water.
5. Place a penny on the table.
6. SLOWLY and carefully drop water onto the penny ONE DROP AT A TIME.
    a. Keep count of how many drops fit onto the penny before the water overflows.
    b. Add to your penny diagrams: single drop, ½ full, and near overflowing
    c. *Record how many drops of water you were able to place on the penny before it overflowed.*
7. Complete steps 4-6 using a new penny and the dropper labeled "alcohol."
    a. *Make sure you complete the diagrams for alcohol and record the number of drops before overflowing.*
8. Respond to the **PART A Discussion Questions** (below) in your science notebook.

Discussion Questions:

- 2A. Which liquid held more drops on the penny? Why do you think this liquid held more drops on the penny?
- 2B. Which liquid do you think holds its molecules together the strongest? What did you observe that could be considered evidence for your explanation?
- 2C. Using this exploration, construct a definition for the terms "surface tension" and/or "cohesion."

Part B - Surface Tension and Cohesion

Task:

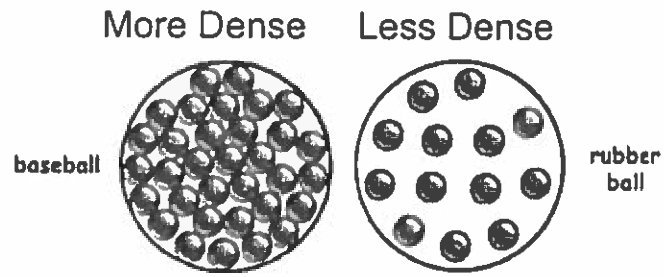
1. Using a steady hand and a plastic spoon, rest the paper clip on the surface of the water. It should NOT sink!
2. *Record your observations in your Data Table.*
3. Clean up your station / station area: Wash and dry off all materials and return them to the condition in which you found them or cleaner.
4. Respond to the **Part B Discussion Questions** in your science notebook.

Discussion Questions:

- 2D. What kept the paperclip floating?
- 2E. If the paper clip breaks the surface of the water, what happens? Why do you think the paperclip behaves this way?
- 2F. The paper clip demonstrates the surface tension and cohesion of water. What do you think these two terms mean?

STATION 3: Density

Why do objects float? A cork floats in water because it is LESS dense than the water. However, objects are MORE dense than water sink. The **density** of an object determines if that object will float or sink depending on what substance it is in.
Molecules of a MORE dense substance are packed closer together. Molecules in a LESS dense substance are more spread apart. This means that the more dense a substance is, the more molecules it holds packed together.



Task Steps:

1. Record the property of water being explored at this station (density).
2. Carefully place a slice of solid vegetable oil in liquid vegetable oil (beaker labeled "oil").
   a. If you don't already have solid vegetable oil, then get a slice from the refrigerator or cooler.
3. *Record your observations in your Data Table.*
4. Place the solid water (ice cube) in the liquid water (beaker labeled "water").
   a. If you don't already have solid water, then get some from the freezer.
5. *Record your observations in y*our Data Table.
6. Clean up your station / station materials:
   a. Pour the beaker of water into the sink. Fill the beaker with the same volume of water before you put in the ice cube (50mL). Dispose of the oil filled beaker in the appropriate container. Fill the beaker with the same volume of oil (50mL). Return all materials to the condition in which you found them or cleaner.

Discussion Questions:

- 3A. Which is denser, solid oil or liquid oil? What did you observe that could prove your argument?
- 3B. How far apart are the molecules of liquid oil compared to molecules of solid oil?
  - Draw a model that compares molecules of liquid oil compared to solid oil.
- 3C. Which is denser solid water or liquid water? What did you observe that is your proof?
- 3D. How far apart are the molecules of liquid water compared to molecules of solid water?
  - Draw a model that compares molecules of liquid water compared to solid water.
- 3E. Think about the differences between solid ice and liquid water. What do you think happens to the molecules of water when they freeze, i.e. turn from a liquid to a solid?

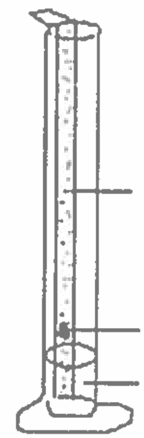
STATION 4: Capillary Action

READ ME! How does water move against gravity from the roots of a tree to the top branches? Well, did you know water can climb? Trees have special tubes to help water climb. Water can also climb up paper! As water travels, it often carries other non water molecules with it.

Part A: Climbing Filter Paper

Task Steps:

1. Record the property of water being explored at this station (capillary action).
2. Observe the strip of paper at this station.
3. Predict how many minutes it will take water to climb up this strip of paper.
   a. Write your prediction in your notebook as *"one centimeter per __ minutes."*
4. Set up the investigation as shown in the image on the right.
   a. Pour water 1 cm deep in the graduated cylinder.
   b. Mark one strip of paper with a light dot of marker 2 cm from the bottom of the paper.
   c. Let it dry completely.
   d. DO NOT PUT THE PAPER IN THE WATER DURING THIS STEP! Tape the paper over the top of the graduated cylinder. The bottom of the paper should nearly touch the bottom of the graduated cylinder. The marker dot should be right above the water.



Set up of filter paper and cylinder

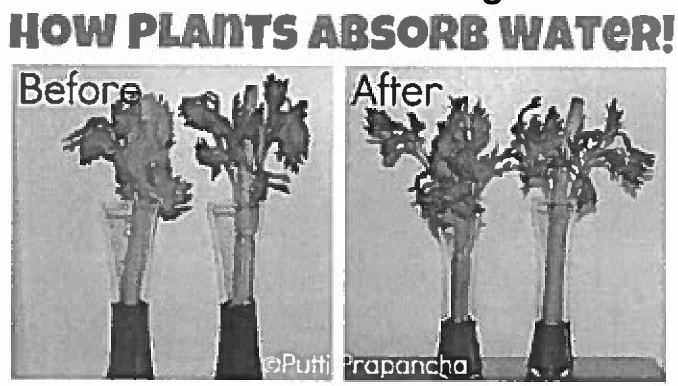
5. Now, place the paper in the beaker with its tip in the water (the marker dot should not be in the water), and **start the timer.**
5. Wait 7 minutes.
6. After 7 minutes, measure and record how far the ink traveled up the paper (in centimeters).
7. Calculate the rate of water flow up the paper in centimeters per minute (__cm per minute).
8. Respond to the **Discussion Questions** below in your science notebook.

Discussion Questions:

- 4A. How does the ink change?
- 4B. Explain why you think the water traveled up the filter paper.

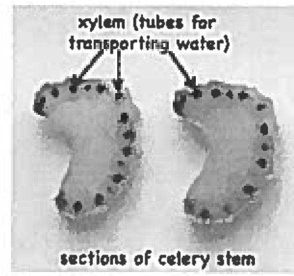
Part B: Climbing a Plant

READ ME! Observe the image to the right. During this experiment, celery was placed in a cup with water mixed with food coloring. The "after" picture on the right is after 5 days. The image in the bottom right shows the tubes for transporting water in a celery plant after 5 days in the blue food coloring.



Task Steps:

1. Observe the images to the right.
2. Record observations of the before and after images in your science notebook.
3. Respond to the **Discussion Questions** below in your notebook.
4. Clean up this station. Make sure everything is set up the way you found it - or cleaner!



Discussion Questions:

- 4C. Why does the celery turn different colors?
- 4D. What is happening to the water molecules that started in the cup?
- 4E. How does this image demonstrate the capillary action of water?

7.1.1 Task Card Properties of Water Output Sheet

Station #	Data (Qualitative observations and quantitative)	Property Being Tested & Possible Definition
1		
2		
3		
4		

The Amazing Properties of Water

Focus Question: How do water's unique properties support life on Earth?

Why do people say that water is necessary for life? Why have we never found any living organism that can flourish in a completely dry environment? How is it that something odorless, colorless, tasteless and relatively unreactive can be so important to life on Earth? Why couldn't another liquid be used? Why water? Water has several properties that make it unique amongst compounds and make it possible for all forms of known life to function.

It is the only natural substance found in all three physical states at the temperatures that naturally occur on Earth.

This means that we see water as a liquid, in rivers and seas, a solid, as snow and ice, and as a gas, as clouds or steam. If this was not the case the water cycle would be completely different (what if water didn't evaporate in the sun?); snow and ice might not exist (and thousands of species would now be homeless) and weather would be very different (would it still rain?). Do you think we could still live if water was only a liquid at the temperatures that occur naturally on Earth? What about only a gas/solid?

Solid water (ice) is less dense than liquid water.

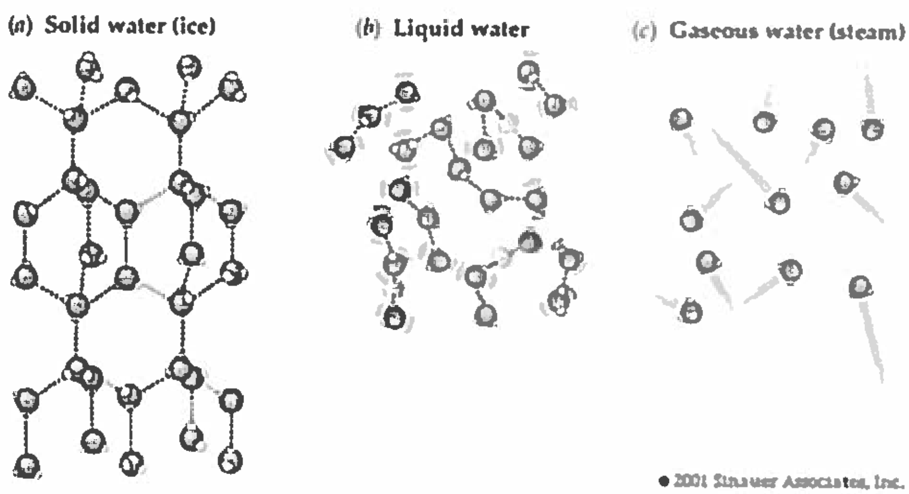


Figure 1. Solid water molecules due to their attraction for other water molecules forms a crystal structure that is less dense (molecules are NOT as close together) than liquid water. Notice the spacing between molecules in each state. Do you see a pattern in the solid water?

The Amazing Properties of Water

This just means that ice floats on water and that lakes freeze from the top down to the bottom since water freezes at 0°C. This is clearly important for animals that live on ice, as their habitats would be greatly reduced or not exist at all if ice sank. Similarly, fish and other pond-life would be affected if lakes and ponds froze from the bottom upwards - the layer of frozen water at the top of the pond provides some insulation and prevents the rest of the water getting cold as quickly. It does this by making a barrier between the cold air and the warmer water below. This means that large bodies of water don't get cold deeper down as fast as they might if ice sank, which helps organisms survive in ponds over winter. In fact, water gets more dense at it is cooled until it reaches 4°C, after which it gets less dense again.

For most substances, objects expand and become less dense with increasing temperature and more kinetic energy. A look closer at the molecules reveals that solid water (ice) forms a crystal structure with a repeating geometric pattern and keeps molecules spread out, whereas liquid water molecules are free to move around and actually are much closer than in a solid state. See Figure 1 on the previous page.

Water is called the 'universal solvent' because it is capable of dissolving so many substances.

Due to water acting like a magnet, water molecules can also attract particles with areas of opposing electrical charges. An example is the dissolving of salt in water. Table salt forms a crystal structure made up of sodium (Na) atoms and chloride (Cl) atoms. Due to water's positive and negative ends, water molecules are able to attract sodium (Na) atoms away from the chloride (Cl) atoms and therefore, break up and dissolve the table salt. See Figure 2.

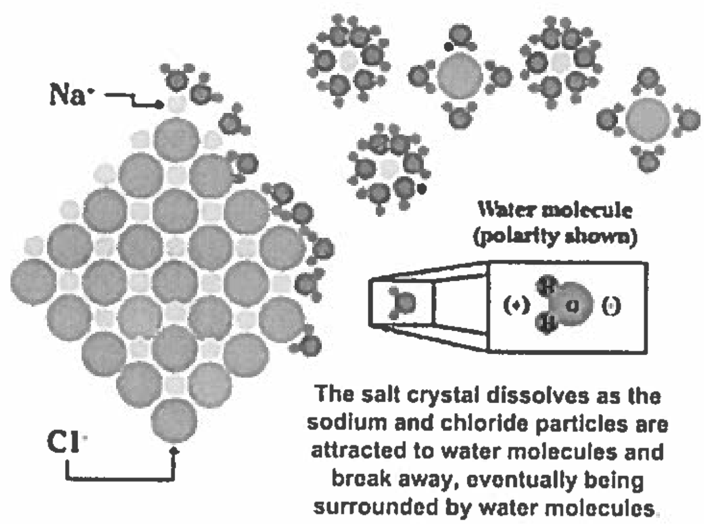


Figure 2. Salt (NaCl) forms a repeating crystal structure and can only be dissolved due to water's (+) and (-) ends.

Compare this to salt in oil. Examining the oil molecule, one cannot find a (+) and (-) area. Instead, oil is said to be a nonpolar molecule and therefore, cannot attract and separate the table salt. See Figure 3 to the left, comparing a water molecule to a typical oil molecule (there are many types). Though fats and oils do not easily dissolve in water, they are still important nutrients to maintaining one's health.

However, the water in our bodies is mostly contained in our cells, where it gives them a clear shape as well as having billions of useful molecules dissolved in it, including nutrients. Our cells need to be filled with water to work properly because some of the important chemicals (enzymes) inside our cells only function when dissolved in water. Water is also the means by which transport occurs in our bodies. Blood is mostly water and has nutrients and gasses dissolved in it that all cells need to survive. Blood also contains toxins such as urea, which are removed from the body with yet more water.

Surface tension

Because each water molecule has polar opposite charges, the water molecules are highly attracted to one another (cohesion). This is especially true at the surface, where the water is much more attracted to itself than it is attracted to the air. It almost seems like water can form a skin on the surface, a property of water called surface tension.

You might have noticed that if you put a needle on the surface of a bowl of water it floats but if you throw it in it sinks. This is because the needle is denser than water so wants to sink but is held up by the surface tension of the water. Surface tension is a property that means the surface of water does not want to break - it is 'sticky'. You can also see this when you fill a cup to the brim, as the surface of the water will hold together and resist spilling. The high surface tension of water is the reason that some flies and other insects can land or walk on its surface without sinking. This concept is also very closely related to another, the idea of climbing action.

Capillary action

Similarly to surface tension, this revolves around the idea that molecules of water 'stick' together. If you put a very small tube into a beaker of water you will see that some of the water travels a short way up the tube; this is called capillary action and is caused by the water clinging to the sides of the tube and to other molecules of water, pulling them up the tube with it. Eventually the weight of the water being pulled is too great to be supported and the water stops moving, having reached an equilibrium. This same principle allows plants to draw water up from the ground; as water molecules travel up the stem more water molecules stick to them and more stick to those and so on until a column of water is being transported in the xylem.

But why?

All of these properties of water are critical for life as we know it but why does water have them? Does no other substance also do these things? What is it about water that makes it different? To understand the answers to these questions you have to study the molecular structure of water.

The chemical formula for water is H_2O, meaning that it contains two hydrogen atoms bonded to one oxygen atom, where the oxygen is slightly negatively charged and that the hydrogens are slightly positively charged. This is called **polarity** and is the key concept behind the properties of water.

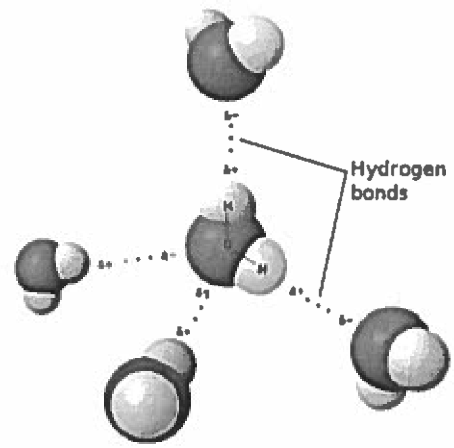


Figure 4. Each water molecule has a positive and negative area to attract other water molecules forming hydrogen bonds between them.

This means that neighbouring water molecules can have the slightly positive hydrogen from one molecule attracted to the slightly negative oxygen on another. These are called hydrogen bonds. See Figure 4. This is why water 'sticks' to itself, giving it high surface tension and the ability to move by capillary action.

A substance will dissolve in water if it is polar. This is because it dissolves by forming hydrogen bonds with the water. Oil is not polar, which is why it will not dissolve. Salt, NaCl, does dissolve because it has areas in its structure that are more positive and negative. Can you think of some other substances that are able to dissolve in water? How do they form hydrogen bonds with it?

Adapted from NRICH.maths.org

TEPAC Analytical Paragraph

Prompt:

Student Response (Topic Sentence/Claim): *After reading the article, "____________________," I think…,*

Evidence ***Provide evidence from the article supporting your claim.***	Paraphrase Evidence ***Summarize this evidence in your own words.***	Analysis of Evidence ***Explain the significance of this piece evidence, or how it supports your claim.***	Concluding Statement ***Explain how your evidence connects back to the topic sentence or theme/claim.***
Rewrite with Academic Language: *According to ________,* *In paragraph _____, ______ said,* *"…."*	Rewrite with Academic Language: *Due to…,* *Being that…,* *Since…,* *In other words,*	Rewrite with Academic Language *Under those circumstances,* *Then, If so, In that case,* *As a result, With this in mind,* *Accordingly, To put it another way,* *Even though,*	Rewrite with Academic Language: *Consequently, As I have said, To summarize, Altogether, Therefore, Thus,*

Write the sentences to create a paragraph. Make sure to include topic sentence.

Periodic Table of the Elements

Grade 8 Science Reference Sheet

California Standards Test

Key

11 — Atomic number
Na — Element symbol
Sodium — Element name
22.99 — Average atomic mass*

	1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1	1 **H** Hydrogen 1.01																	2 **He** Helium 4.00
2	3 **Li** Lithium 6.94	4 **Be** Beryllium 9.01											5 **B** Boron 10.81	6 **C** Carbon 12.01	7 **N** Nitrogen 14.01	8 **O** Oxygen 16.00	9 **F** Fluorine 19.00	10 **Ne** Neon 20.18
3	11 **Na** Sodium 22.99	12 **Mg** Magnesium 24.31											13 **Al** Aluminum 26.98	14 **Si** Silicon 28.09	15 **P** Phosphorus 30.97	16 **S** Sulfur 32.07	17 **Cl** Chlorine 35.45	18 **Ar** Argon 39.95
4	19 **K** Potassium 39.10	20 **Ca** Calcium 40.08	21 **Sc** Scandium 44.96	22 **Ti** Titanium 47.87	23 **V** Vanadium 50.94	24 **Cr** Chromium 52.00	25 **Mn** Manganese 54.94	26 **Fe** Iron 55.85	27 **Co** Cobalt 58.93	28 **Ni** Nickel 58.69	29 **Cu** Copper 63.55	30 **Zn** Zinc 65.39	31 **Ga** Gallium 69.72	32 **Ge** Germanium 72.61	33 **As** Arsenic 74.92	34 **Se** Selenium 78.96	35 **Br** Bromine 79.90	36 **Kr** Krypton 83.80
5	37 **Rb** Rubidium 85.47	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.91	40 **Zr** Zirconium 91.22	41 **Nb** Niobium 92.91	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.91	46 **Pd** Palladium 106.42	47 **Ag** Silver 107.87	48 **Cd** Cadmium 112.41	49 **In** Indium 114.82	50 **Sn** Tin 118.71	51 **Sb** Antimony 121.76	52 **Te** Tellurium 127.60	53 **I** Iodine 126.90	54 **Xe** Xenon 131.29
6	55 **Cs** Cesium 132.91	56 **Ba** Barium 137.33	57 **La** Lanthanum 138.91	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.95	74 **W** Tungsten 183.84	75 **Re** Rhenium 186.21	76 **Os** Osmium 190.23	77 **Ir** Iridium 192.22	78 **Pt** Platinum 195.08	79 **Au** Gold 196.97	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.38	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.98	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
7	87 **Fr** Francium (223)	88 **Ra** Radium (226)	89 **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (266)	107 **Bh** Bohrium (264)	108 **Hs** Hassium (269)	109 **Mt** Meitnerium (268)									

58 **Ce** Cerium 140.12	59 **Pr** Praseodymium 140.91	60 **Nd** Neodymium 144.24	61 **Pm** Promethium (145)	62 **Sm** Samarium 150.36	63 **Eu** Europium 151.96	64 **Gd** Gadolinium 157.25	65 **Tb** Terbium 158.93	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93	70 **Yb** Ytterbium 173.04	71 **Lu** Lutetium 174.97
90 **Th** Thorium 232.04	91 **Pa** Protactinium 231.04	92 **U** Uranium 238.03	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** Nobelium (259)	103 **Lr** Lawrencium (262)

* If this number is in parentheses, then it refers to the atomic mass of the most stable isotope.

Formulas and Conversions

Density: $D = \frac{m}{V}$

Average Speed: $v = \frac{d}{t}$

Length: 1 m = 100 cm
1 km = 1000 m

Mass: 1 kg = 1000 g

Volume: 1 L = 1000 mL = 1000 cm^3

Water at Room Temperature: 1 mL = 1 cm^3 = 1 g

What I <u>Think</u> I ALREADY Know About Elements

Element Symbol	Element Name	What I Think I ALREADY Know About this Element
1) Ne	Neon	Gas, glows when exposed to electricity, used for business signs
2)		
3)		
4)		
5)		
6)		
7)		
8)		
9)		
10)		
11)		
12)		
13)		
14)		
15)		

10 Most Important/Common Elements

My Group's List

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

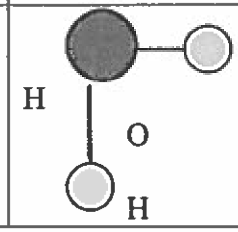
Updated List based on Reading

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Exit:

What do **Molecules** and **Compounds** look like?

NAME:__________________
PERIOD:_______

Chemical Formula & Name of Compound	1st Element	Number of Atoms	2nd Element	Number of Atoms	Drawing	Molecule or Compound?
H_2O Name: Water	Hydrogen	2	Oxygen	1		Compound
Individual Practice						
HCl						
O_2						
HF						
P_4						

Notes

NAME:____________________
PERIOD:_______

What do **Molecules** and **Compounds** look like?

HBr						
S_8						
H_2S						
H_2Se						
H_2Te						
H_2S_2						

ELEMENT SUPERHERO PROJECT

Superhero Name

(Must include the element in the name)

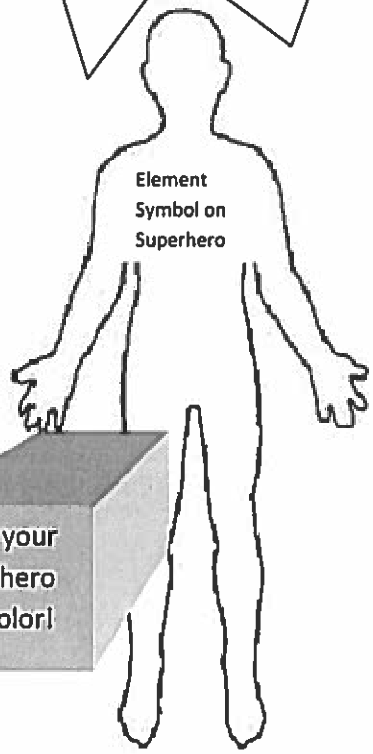
Atomic Number

Symbol

Element Name

Atomic Mass

(As it appears on the periodic table)



Draw your superhero and color!

FIVE INTERESTING FACTS ABOUT THE ELEMENT:

Websites that may help you:

http://www.chemicool.com/

http://www.webelements.com/

http://chemistry.about.com/library/blperiodictable.htm

There is also a Nova Elements app that you may find helpful.

SUPERHERO DESCRIPTION:

Write a paragraph describing everything about your superhero. Be creative!

How does the element give your superhero powers?

When and how did your superhero discover his/her powers?

Where does your superhero live?

Where did your superhero come from?

What does your superhero do when he/she is not saving the world?

What is your superhero's human name?

ELEMENT SUPERHERO PROJECT RUBRIC

	25	20	18	15	Points
Creativity	Project is excellent. Obvious, high quality effort is shown.	Project shows good effort and quality.	Project shows average effort and quality.	Poorly drawn/created, showing obvious signs of rushing or lack of effort.	
Neatness/Grammar	Presentation is neat and easy to read. No misspellings or grammatical errors.	Presentation is moderately neat and has no more than two misspellings and/or grammatical errors.	Project is moderately neat, hard to read, and has three or more misspellings and/or grammatical errors.	Presentation lacks neatness, is difficult to read, and/or has many misspellings or grammatical errors.	
Delivery	Student used a clear voice and correct, precise pronunciation of terms.	Student's voice is clear. Student pronounces most words correctly.	Student incorrectly pronounces terms or audience members have difficulty hearing the presentation.	Student mumbles, incorrectly pronounces terms and speaks too quietly for students in the back of the class to hear.	
				SUBTOTAL →	

Required Components	4-5	1-3	Points
Superhero Name	Good to Excellent	Minimal to Good	
Superhero Drawing	Good to Excellent	Minimal to Good	
Element Symbol Box	Good to Excellent	Minimal to Good	
5 Interesting Facts	Good to Excellent	Minimal to Good	
Superhero Description	Good to Excellent	Minimal to Good	
		SUBTOTAL →	

GRAND SUPERHERO TOTAL:____________________

Name: ____________________
Date: ________
Period: ________

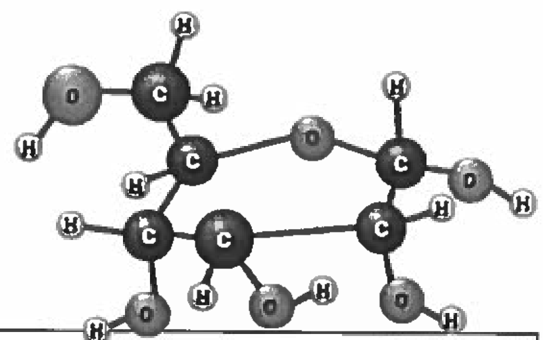
Atoms Assessment

A mystery molecule is discovered in the wastewater that is SMALLER than the water molecule. Mike thinks the mystery molecule will be ***filtered out of the water during reverse osmosis.*** Maria thinks that the mystery molecule will ***remain in the water after passing through both stages of filtration.***

Who do you agree with? ____________ Who do you disagree with? ____________

What could you say to that person to convince them that their idea is not correct?

Mario, Joseph, and Amy are using glucose ($C_6H_{12}O_6$) during a science lab.
Mario says "glucose is a ***molecule***."
Joseph says "glucose is a ***compound***."
Amy says "glucose is ***both a molecule and a compound***."
Who do you agree with the most and why?



Glucose

Name: ____________________

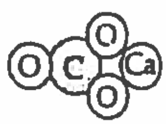
Date: __________

Period: __________

There are 3 types of elements on the periodic table. What type of element would Tungsten (W) be? Circle the answer and explain how you know that it is that type of element.

Metal Nonmetal Metalloid

Complete the chart below

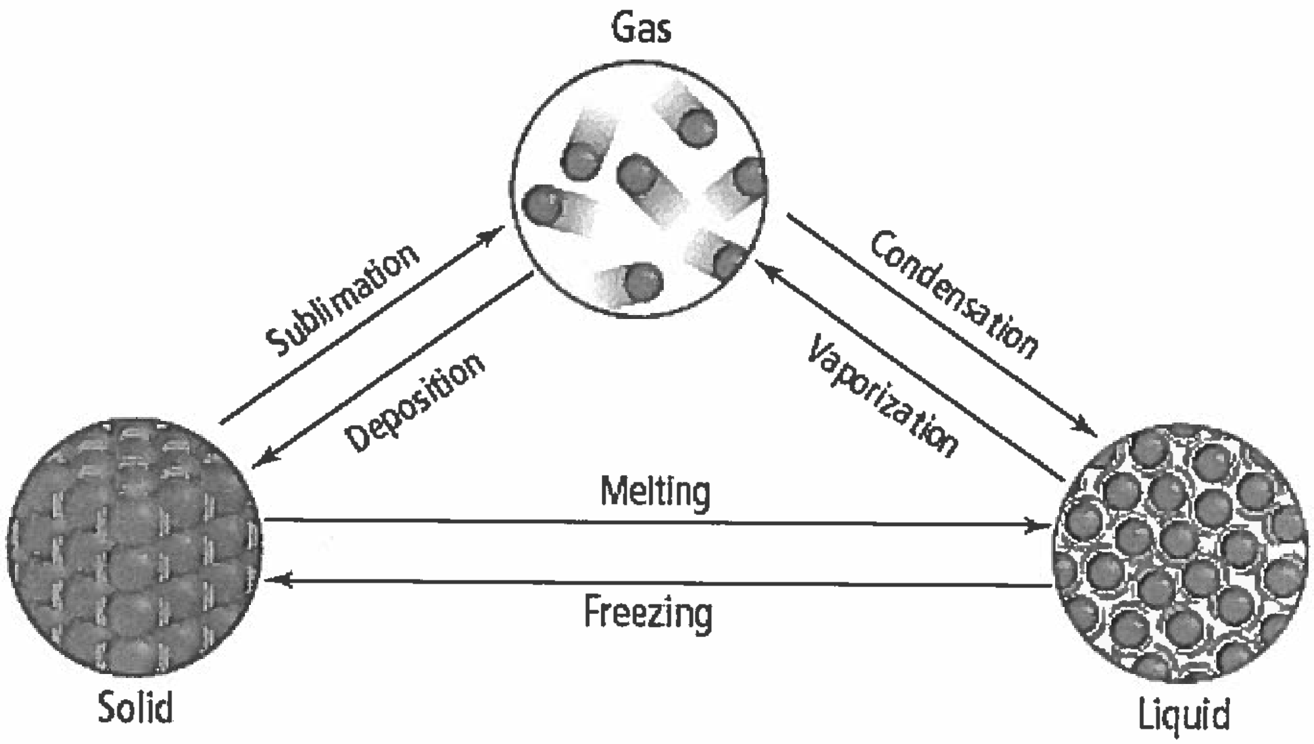
Substance Name	Chemical Formula	Representation	Number of Elements	Number of Atoms
Calcium Carbonate				

Fill in the empty boxes and create your own atomic animal problem.

Elements in the Compound	Element Symbols	How Many Total Elements
Example: Carbon, Astatine	*C + At = CAt*	*2*
Molybdenum, Uranium, Selenium		
Create your own atomic animal problem below and answer it		

Lathrop Intermediate

7th grade Science
Phase Change Unit



Focus Question: Do all substances change phases in the same way?

Safety Precaution: Dry ice is extremely cold and can damage unprotected skin. Always use a tool when handling dry ice. Follow the instructions carefully to prevent injury. Dispose of any unused portion in a beaker of water. DO NOT REMOVE DRY ICE FROM THE CLASSROOM.

Materials:

- 2 glass beakers
- 2 empty, plastic water bottle
- 2 balloons
- 1 plastic spoon -or- tongs for handling the dry ice
- measuring cup
- cup for transporting dry ice
- 2 paper towels (one for handling the dry ice, and one for clean-up)
- 1 kettle to heat water (teacher)
- 1 water ice cube
- 3 small pieces of dry ice in a cup
- 1 drop of dishwashing liquid

Procedures:

1. Copy the Table 1 into your notebook, leaving space to draw and write observations/explanations.
2. Review the Group Roles. Decide on the roles and responsibilities for each student in your group.
3. Collect the materials.
4. During each TASK, do the following for BOTH dry ice and water ice:
   a. a labeled diagram with any observations describing what you SEE happening
   b. possible explanation for either: what is causing the changes
5. **TASK ONE:** Using the spoon, put the largest piece of dry ice into the empty, plastic water bottle, and attach the balloon on top. Place a similar sized piece of ice into the second empty bottle and attach a balloon on top. If needed, label the bottles so there is no confusion. Observe these throughout the completion of the remaining tasks.
6. **TASK TWO:** Place a water ice cube in a beaker and a dry ice cube in another beaker. Wait a few minutes and observe the phase changes.
7. **TASK THREE:** Using the spoon, place a small piece of dry ice on your lab table. Place the water ice cube next to it. Give each a little push and observe their motion.
8. **TASK FOUR:** Add a half cup of warm water to each beaker containing water ice and dry ice. Compare what happens.
9. **TASK FIVE:** Add a drop of dishwashing liquid to each of the beakers of water ice and dry ice From Task Two.

10. Once your group has finished all the tasks, clean up your workspace, and return all clean equipment to your teacher.

Table 1

TASK #	DIAGRAM and OBSERVATIONS of DRY ICE	DIAGRAM and OBSERVATIONS of WATER ICE	EXPLANATION (what you think is causing the phase changes)
1			
2			
3			
4			
5			

Discussion Questions:

1. What phase change did you observe with the dry ice? Provide observations to support your claim.

2. What phase change did you observe with the regular ice? Provide observations to support your claim.

3. How does water behave differently (its properties) as a liquid compared with as a solid?

4. How does carbon dioxide behave differently (its properties) as a gas compared with as a solid?

5. What is causing the change in the dry ice and the water ice? Describe what is happening at the molecular level to the substances (water and carbon dioxide) as they experience a phase change.

Solid Water and Dry Ice Analysis Questions:

1. What phase change did you observe with the <u>dry ice</u>? Provide observations to support your claim.

2. What phase change did you observe with the <u>regular ice</u>? Provide observations to support your claim.

3. How does water behave differently (its properties) as a liquid compared with as a solid?

4. How does carbon dioxide behave differently (its properties) as a gas compared with as a solid?

5. What is causing the change in the dry ice and the water ice? Describe what is happening at the molecular level to the substances (water and carbon dioxide) as they experience a phase change.

Name: ______________________________ Date: ___________ Period:

States of Matter READING Resource Page

Focus Question: How do particles in the three states of matter behave differently?

What's the Matter?

Think about the different states you have observed water in: the solid ice you place in a drink on a hot day, the water vapor that you breathe out onto a window on a cold day, and the liquid that living things need to survive. All three of these examples, though different in appearance, are actually made of the same exact tiny particles that make up water. All organisms and nonliving substances, like water, on Earth are are also made up of similar particles called **atoms** that when arranged in different combinations make up all **matter** in the universe. Thus, these microscopic **atoms** can be called the basic building blocks of all matter. Atoms can also bond with each other to create combinations, e.g. a carbon dioxide **molecule** is made up of 2 oxygen atoms combined with one carbon atom (see Figure 1).

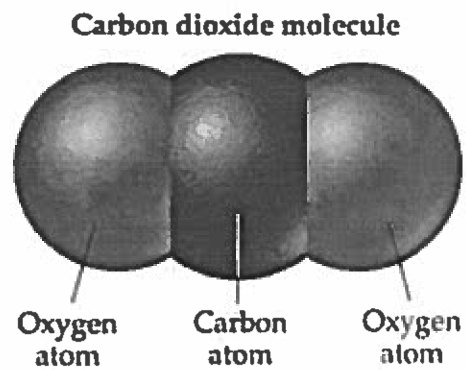


Figure 1. Atoms that make up a carbon dioxide (CO2) molecule. (Taken from CUNY.edu)

Matter — Solid, Liquid, Gas

On Earth, matter is mostly found either as a solid, liquid, or gas, but all are made up of atoms. To the right are simplified models of these three different states of matter. One is a solid, another is a liquid and the other is a gas. In Figure 2, the little motion lines show that the particles (atoms or molecules) that make up the solid, liquid, and gas are moving. You will also notice that the three states are all made of the same particles. However, one main difference that defines each state is the speed of the particles' motion or movement. Thus, the larger the arrow connected to the atom, the FASTER the particle is moving.

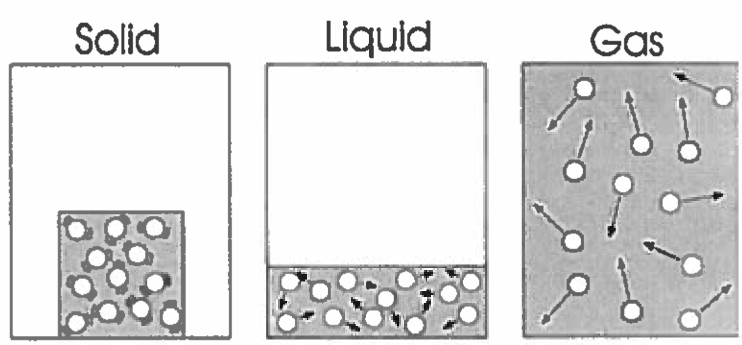


Figure 2. The states of matter defined by particle motion: (a) particles in a solid vibrate but stay in place, (b) liquid particles move more than a solid, (c) particles in a gas move the fastest.

Attraction Compared to Motion

Another big idea is that the atoms or molecules that make up a solid, liquid or gas are attracted to each other (much like a magnet is attracted to a nail). When studying different states of matter, the atoms or molecules are competing between the attraction they have for each other as opposed to the motion of their molecules. The attraction tends to keep the atoms or molecules together, while the motion tends to make the atoms or molecules moving farther apart. When in motion, the particles are said to have more **kinetic** energy (the energy of motion) the faster they move. In Figure 3, notice the difference in spacing between the particles for a solid, liquid, and gas. What would happen if one could increase the overall kinetic energy (**thermal** energy) of the particles in one of the states?

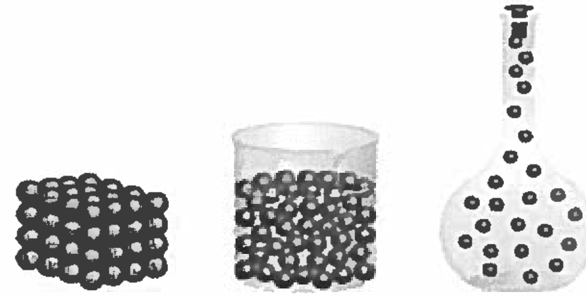


Figure 3. The spacing between the particles in the three states of matter.

In a **solid**, the atoms are very attracted to one another. Because of this strong attraction, the atoms are held tightly together. The attractions are strong enough that the atoms can only vibrate where they are. They cannot move past one another. This is why a solid keeps its shape, meaning solid has a definite shape and occupies a definite space (volume).

In a **liquid**, the molecules are also in motion. The attractions between the molecules in liquids are strong enough to keep the molecules close to each other, but they don't have to be in the same place and can move past one another. This is why a liquid can easily change its shape, meaning that liquid has undefined shape (copies the shape of its container) but occupies a definite space (volume).

In a **gas**, the molecules are also moving. The attractions between the molecules of a gas are too weak to bring the molecules together. This is why gas molecules barely interact with one another and are very far apart compared to the molecules of liquids and solids.

Heating and Cooling:

Heating and cooling a substance can affect how far apart or close together the molecules are. One example is the red alcohol inside the thin tube of a thermometer. When the thermometer is heated, the molecules of alcohol move faster. This faster motion competes with the attraction between the molecules which causes them to spread out a little. Thus, the molecules now have more kinetic energy and spread out more. They have nowhere else to go so they move up the tube.

When the thermometer is cooled, the molecules of alcohol slow down and the attractions bring the molecules closer together. As a result, the molecules have less kinetic energy and this attraction between the molecules brings the alcohol down in the tube. Another example is with water molecules as seen in Figure 4.

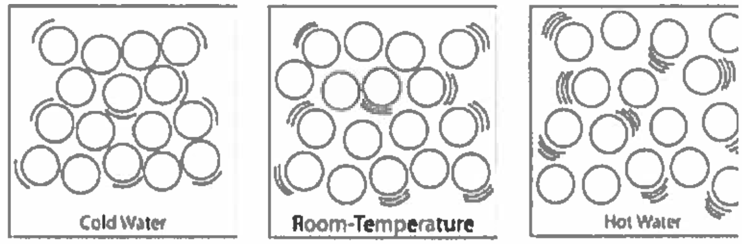


Figure 4. Images of water molecules and different temperature. Notice the difference in movement and spacing.

Kinetic Energy and Changing Phases:

Since molecules are always moving, any substance has a certain amount of kinetic energy. Here is an example of a cold spoon in hot liquid, the molecules of hot liquid are moving quickly so they have a lot of kinetic energy. The fast-moving molecules from the hot liquid transfer some of their kinetic energy to the slower atoms of the cool spoon so that these slower atoms now have more kinetic energy. This process of transferring energy by direct contact is called **conduction**. The opposite is also true where a hot metal spoon is put into cool air in a fridge. The atoms in the spoon transfer some of their energy to the air molecules in the fridge, making the spoon cool down and lose energy.

This transfer of energy can also lead to a **phase change**, where enough kinetic energy has been added to or removed from a substance so that the particles that make up that substance change how they behave. For example in Figure 5, as energy is added to solid, the particles move more and spread out. However, as energy is removed, the gas particles slow down and move closer together. Yet, not all substances behave the same, e.g. water is the only substance where as a liquid, the molecules are closer together than as a solid. Thus, solid water floats on top of liquid water.

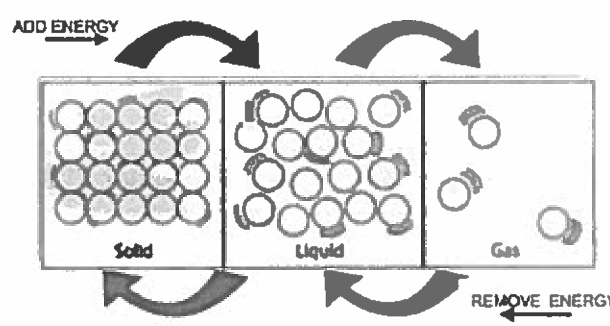


Figure 5. The phase changes caused by adding and removing energy

Adapted from "Chapter 1 and 2 - Middle School Chemistry Unit" American Chemical Society 2011

Create a model of what happens to the dry ice during this phase change. Show what happens BEFORE the phase change and what happens AFTER the phase started changing.

In addition, here is some information to help with your model and explanation:

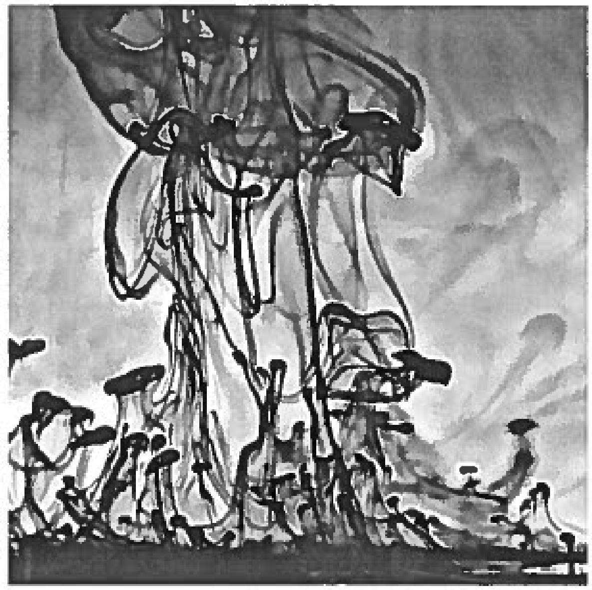
- Room temperature : 25℃
- Sublimation point of dry ice: -56.6℃

Your model will:

- ❑ Show dry ice as individual particles
- ❑ Identify dry ice's state of matter BEFORE and AFTER the phase change started
- ❑ Show glass beaker as part of the system
- ❑ Demonstrate spacing between the particles and particle motion of dry ice in two different states
- ❑ Show energy transfer between two objects

Thermal Energy and Molecular Motion : Food Coloring

Essential Question: Are the speed of water molecules different in hot and cold water?



Materials:

- Hot water in a clear glass/jar
- Cold water in a clear glass/jar
- Food coloring (yellow and blue)

Procedure:

1. Fill a glass halfway with ice cold water (minus the ice).
2. Fill the other glass halfway with hot water.
3. Use droppers to carefully place 1 drop of yellow and 1 drop of blue food coloring into each glass at the same time.
4. Allow the colors to mix on their own as you watch them for a couple of minutes.
5. Work with your group to answer the following questions in your notebook. Use to the rubric to guide your group's work.

Observations and Conclusions

List Rubric

TASK	3	2	1	0
THOUGHTFUL, DETAILED, COMPLETE SENTENCES Student fills the spaces provided with thoughtful, detailed sentences that answer all of the questions provided.				
SCIENTIFIC VOCABULARY AND CONCEPTS Student demonstrates an understanding of unit vocabulary and scientific concepts (highlight vocabulary words)				
TEAMWORK AND USE OF CLASS TIME Student uses class time wisely and works together effectively in groups to discuss questions and answer them in her/his own words.				

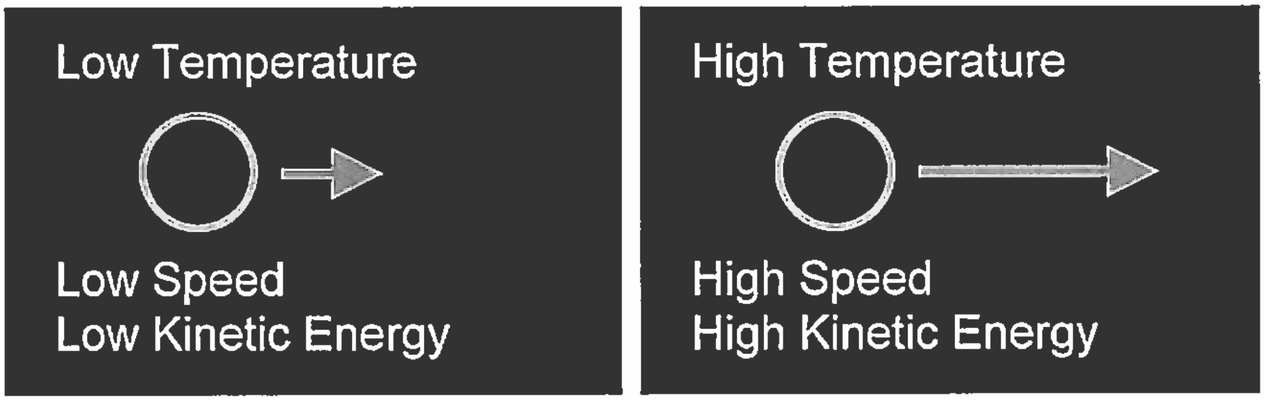
OBSERVATIONS: Answer these 3 questions in your notebook. Use complete sentences.

1. Describe what the colors looked like and how they moved and mixed in the cold water.
2. Describe what the colors looked like and how they moved and mixed in the hot water.
3. What does the speed of the mixing colors tell you about the speed of the molecules in hot and cold water?

Student Task Card - PART 1

Thermal Energy and Molecular Motion : Modeling Kinetic Energy

At a low temperature a gas molecule travels, on the average, at a slower speed than than it would at a high temperature. So, at a low temperature the molecules have, on the average, less kinetic energy than they do at a high temperature. Lower speeds, lower kinetic energies. If we imagine a gas molecule as a green circle:



Instructions:

1) Open up the multimedia simulator : Heating and Cooling a Liquid
http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/ks3/science/changing_matter/index.htm
Or you can look at:
http://www.harcourtschool.com/activity/states_of_matter/index.html

2) Move the controls to add or remove heat.

3) The little circles represent the particles of a liquid, in this case water molecules. Focus on the motion of the molecules, how they interact, and their distance from one another.

Discussion Questions:

1. **Are the molecules moving faster in cold or hot water?**
2. **How does this match with your observations with the food coloring?**
3. **Look closely at the space between the molecules in cold and hot water. Is there more space in between the molecules in hot water or in cold water? Is it a lot of space?**

MODELING ACTIVITY

In your notebooks, draw and label models of water molecules illustrating each of the following statements:

1. Heating a substance increases kinetic energy.
2. Cooling a substance decreases kinetic energy.
3. As kinetic energy increases, the space between molecules increases.
4. As kinetic energy decreases, the space between molecules decreases.

Solid, Liquid, or Gas?

Essential Question: *What classifies something as a solid, liquid, or a gas?*

Prior Knowledge: Explain what classifies something as a solid, liquid, or a gas.

Draw each (S,L,G) on the molecular level.

GAS	LIQUID	SOLID

After Investigation: Explain what classifies something as a solid, liquid, or a gas.

Draw each (S,L,G) on the molecular level.

GAS	LIQUID	SOLID

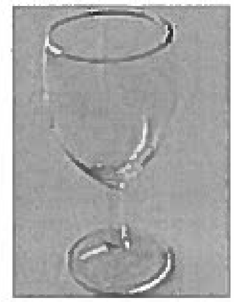
States of Matter Online Interactive

Use the interactive website to complete the questions below. http://bit.ly/SLG26

GASES

1. Describe the motion of the atoms in the gas.

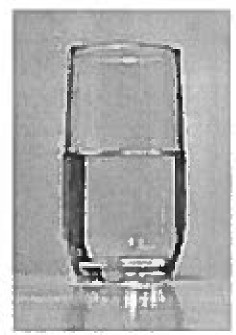
2. The image shows a seemingly empty glass. Why can't you store a fixed (exact) amount of gas in an open container like a glass?



LIQUIDS

3. Describe the movement of the atoms in a liquid. How do they move relative (compared) to each other?

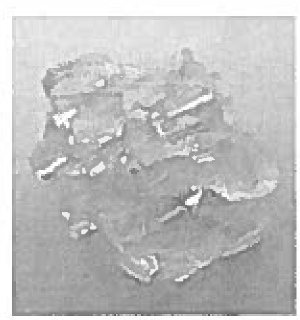
4. The image shows a glass, half-filled with water. Why does the liquid expand to fill the bottom of the glass?



SOLIDS

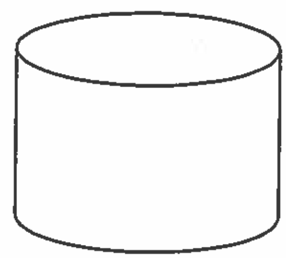
5. Describe the movement and arrangement of atoms in a solid.

6. The image shows a crystal of rock salt (halite). Why does the solid have a specific shape? Why does it not change shape?



Name:______________
Date: ___ Period:__

States of Matter
SOLID Graphic Organizer

State	1. Solid
Definition	
Particle Arrangement	
Example	
Movement	
Picture	
Questions? Level 1: Simple" questions. There is only 1 ght answer. Level 2: Think" questions. These questions /ill require the person to search for ıe answer. There is a correct nswer, but your answers may vary ·om someone else's answer. Level 3: Think Beyond" Question. ʽhis question has no right answer, ut does need you to use evidence. ʽhis is more opinion based. .	Level 1: Level 2: Level 3:

Name:________________
Date: ___ Period:___

The 3 Main States of Matter

Day 1: What is a Solid?

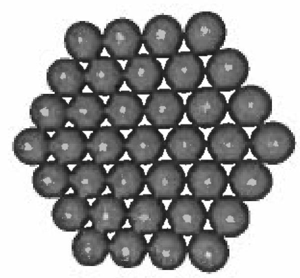
Matter
Cloze Notes

Matter is __________ that has volume and _________. All Matter is made of atoms and molecules that are constantly ____________. The ___________ of the particles and how they are ___________ determine the ________ of Matter they are in, either a Solid, _______, or _______.

What is a Solid?

Solids

Solids are all around us. Your desk is a solid, and so is the chair you are sitting in. Solids are different from other states of matter in that solids are able to hold their shape. In a solid the molecules are pressed very tightly together. This helps the solid keep its shape.

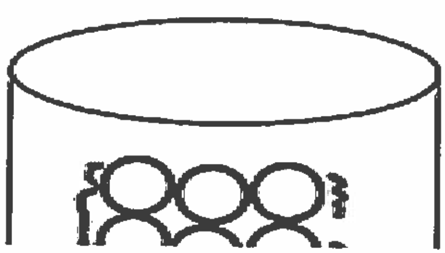


A solid has a definite shape and volume. The molecules in a solid move by vibrating around a fixed point. When energy is added to a solid the molecules will begin to speed up and the solid will change its state of matter to a liquid or a gas.

volume: the amount of space occupied by a three dimensional object.

Read Further….

A solid is: anything that has a fixed shape and volume. How are the particles arranged?: Packed tightly together. They are locked in position and can only vibrate in place. For example: Trees are solid. They are made up of tiny particles called molecules. These molecules are packed closely together and they hold the solid in a definite shape that does NOT change. Additional examples would be like things around your home, like tables, chairs, televisions, and even the food you eat. These are all solids How do solids move, if they are locked in one shape? They mainly stay in one place and *vibrate*. The movement of solid molecules is very little. An example of how it would be drawn is shown below:



Draw a picture to show what the molecules in a solid pencil would look like:

Brainpop: States of Matter

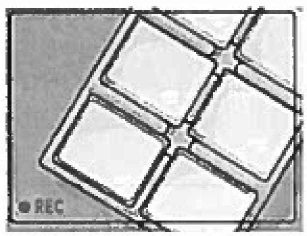
Ice Example: **Solid**

I. When you lower the temperature of water you are removing energy, as a result particles ___________(DO/DO NOT) move around as much.

II. ___________(Liquids/Solids) have a definite shape and ___________(color/volume)

a. What does this picture below tell us about the shape of water as a SOLID?

____



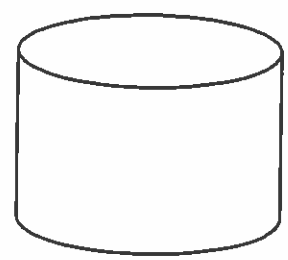
What did the brainpop say about the temperature of water as a Solid?

What is the **state of matter?**	LIST **10** items that can be classified as a **SOLID**
DESCRIBE how the **molecules appear** to be moving? (use the word energy)	

Name:__________________

Date: ___ Period:___

States of Matter
LIQUID Graphic Organizer

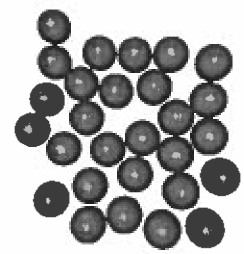
State	2. LIQUID
Definition	
Particle Arrangement	
Example	
Movement	
Picture	
Questions? Level 1: Simple” questions. There is only 1 ght answer. Level 2: Think” questions. These questions /ill require the person to search for ıe answer. There is a correct nswer, but your answers may vary ’om someone else’s answer. Level 3: Think Beyond” Question. ’his question has no right answer, ut does need you to use evidence. ’his is more opinion based.	Level 1: Level 2: Level 3:

Name:______________
Date: ___ Period:____

The 3 Main States of Matter

Day 2: What is a Liquid?

Liquids



Matter in the liquid state can flow and change its shape. Liquids will take the shape of their container. Even though liquids can change their shape, their volume (the amount of space they take up) does not change. The molecules in a liquid are farther separated than those in a solid. The molecules collide with and slide past each other, but remain close together

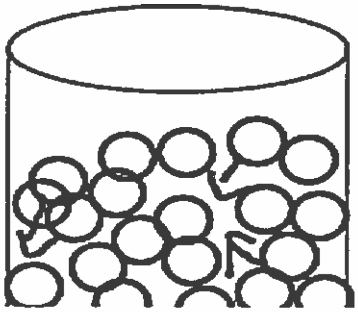
This gives a liquid its ability to change shape and flow. When you dive into a swimming pool full of water, the molecules of water are able to slide apart to make room for your body in the pool.

Liquids have a definite volume but no definite shape. When energy is added to a liquid its molecules will begin to move faster and its state of matter will change to gas. If a liquid loses energy its molecules will slow down and it will change into a solid.

Read Further....

The definition is that liquids have a fixed volume but change shape to match container. The particle arrangement: Loosely packed together. An example would be *Milk.* Have you ever spilt milk on the floor? What happened? The milk spread out across the floor, because the milk is taking the shape of the floor.

A key property of liquids is that they flow and can be poured. The movement of the molecules would be faster then a solid. Fast enough to be able to slide past each other. Very smooth motions, to flow like a river. An example of how it would be drawn is shown below:



Draw a picture to show what the molecules in a liquid glass of milk would look like:

Brain POP: Liquids

Glass of Water Example: **Liquid**

III. Water is made up of tiny particles called __________(molecules/carbon).

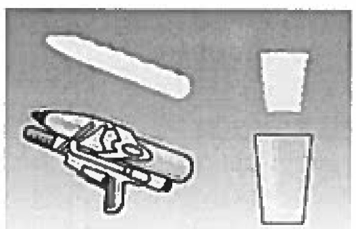
IV. At room temperature, and in normal atmospheric pressure, water molecules form a __________(solid/liquid).

a. The particles of a liquid move around and __________(jump/slide) past one another pretty regularly.

b. Liquids have a fixed __________(volume/shape) but NOT a fixed __________(volume/shape).

c. What does this picture below tell us about the shape of water as a LIQUID?

____



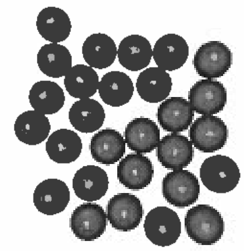
What is the **state of matter?** DESCRIBE how the **molecules appear** to be moving? (use the word energy)	LIST **10** items that can be classified as a **LIQUID**.

Name: **Page: 107**
Date: ___ Period:____

The 3 Main States of Matter

Day 2: What is a Liquid?

Liquids



Matter in the liquid state can flow and change its shape. Liquids will take the shape of their container. Even though liquids can change their shape, their volume (the amount of space they take up) does not change. The molecules in a liquid are farther separated than those in a solid. The molecules collide with and slide past each other, but remain close together

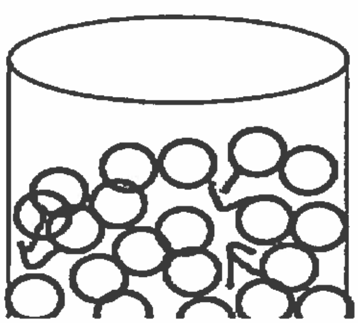
This gives a liquid its ability to change shape and flow. When you dive into a swimming pool full of water, the molecules of water are able to slide apart to make room for your body in the pool.

Liquids have a definite volume but no definite shape. When energy is added to a liquid its molecules will begin to move faster and its state of matter will change to gas. If a liquid loses energy its molecules will slow down and it will change into a solid.

Read Further....

The definition is that liquids have a fixed volume but change shape to match container. The particle arrangement: Loosely packed together. An example would be *Milk*. Have you ever spilt milk on the floor? What happened? The milk spread out across the floor, because the milk is taking the shape of the floor.

A key property of liquids is that they flow and can be poured. The movement of the molecules would be faster then a solid. Fast enough to be able to slide past each other. Very smooth motions, to flow like a river. An example of how it would be drawn is shown below:



Draw a picture to show what the molecules in a liquid glass of milk would look like:

Brain POP: Liquids

Glass of Water Example: **Liquid**

III. Water is made up of tiny particles called ___________(molecules/carbon).

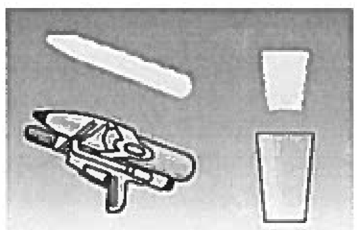
IV. At room temperature, and in normal atmospheric pressure, water molecules form a ___________(solid/liquid).

a. The particles of a liquid move around and ___________(jump/slide) past one another pretty regularly.

b. Liquids have a fixed ___________(volume/shape) but NOT a fixed ___________(volume/shape).

c. What does this picture below tell us about the shape of water as a LIQUID?

____

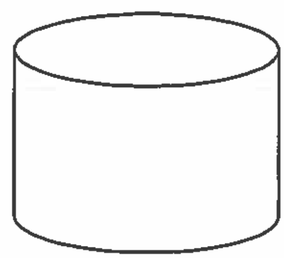


What is the **state of matter?**	LIST **10** items that can be classified as a **LIQUID**.
DESCRIBE how the **molecules appear** to be moving? (use the word energy)	

Name: ____________

Date: ___ Period: ____

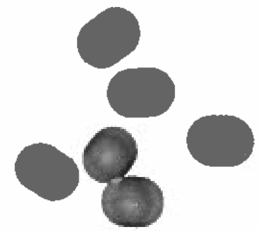
States of Matter
Gas Graphic Organizer

State	3. GAS
Definition	
Particle Arrangement	
Example	
Movement	
Picture	
Questions? Level 1: Simple" questions. There is only 1 ght answer. Level 2: Think" questions. These questions /ill require the person to search for ne answer. There is a correct nswer, but your answers may vary 'om someone else's answer. Level 3: Think Beyond" Question. 'his question has no right answer, ut does need you to use evidence. 'his is more opinion based.	Level 1: Level 2: Level 3:

The 3 Main States of Matter

Day 3: What is a Gas?

Gas



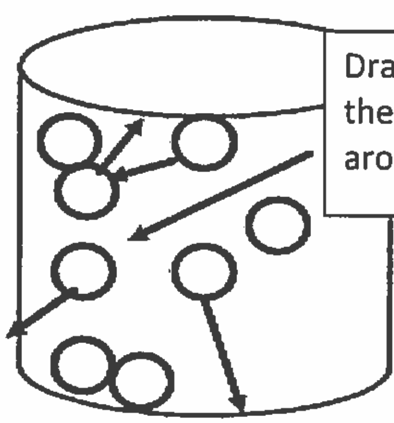
Gasses are similar to liquids because they also take the shape of their container. Unlike liquids, gasses will fill up whatever container they are placed in. The particles of a gas have lots of energy and move away from each other in all directions. Gasses are also one of the only states of matter that can be compressed or squeezed down to fit in a smaller container. A SCUBA diver might use a machine to compress a large amount of air into a small tank. This allows the diver to breath underwater for a long time.

Gasses do not have a definite volume or a definite shape. When energy is added to a gas its molecules separate even more. The greater amount of empty space between the molecules makes the volume of the gas larger. If energy is lost from a gas the molecules will slow down, become closer, and it will change its state to a liquid or solid.

Read Further…

Every day, every minute, you are breathing oxygen, a gas. The air is spread out across the empty space around the Earth. You've probably noticed you usually cannot see the air. Although we cannot see them, you come in contact with gases every day. Another example is that there is air in the tires of your family car or your bicycle.

The definition of the gas state of matter is that gas particles do not have a definite shape or volume. Like liquids, gasses will take the shape of their containers. The arrangement of the gas particles is chaotic, there is no order. Molecules in a gas move freely and collide frequently with each other. The molecules bounce off each other and the walls like a pinball machine. The movement of the molecules is very fast, and they bump into each other a lot! The nonmetal elements on the periodic table are gasses!

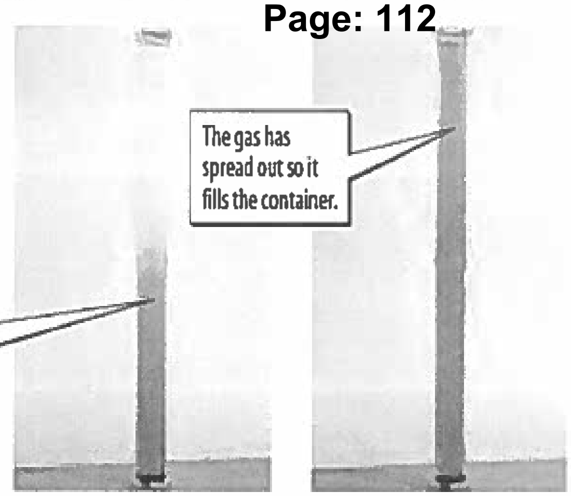


Draw a picture of how the gas particles move around our classroom:

Use Figure 6 to help you answer the questions below.

1. How has the gas changed from the first picture to the second picture?

Figure 6 A gas spreads out until it has the same volume as its container.
Describe how the volume of the gas changes.



2. How can you tell the container has a lid?

3. What do you think would happen if the container didn't have a lid?

Brainpop: Tea Pot Example - Gas

I. If we boil water it will change state, and become a ___________(liquid/gas).

II. When you increase the temperature of the water, you're adding ___________(energy/particles) to it.

a. The particles get ___________(tired/excited), then they start moving faster and away from each other.

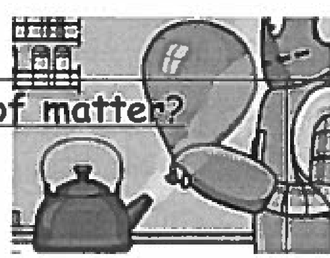
b. The changes in state are only physical the chemical structure stays the same. The water particles are still water molecules H20, ___________(Hydrogen/Chlorine) and ___________(Oxygen/Sodium).

c. Unlike liquids, GASES DO NOT have a fixed ___________(volume/color), they can expand and fill up any container you put them in.

d. What does this picture below tell us about the shape of water as a GAS?

____

What is the state of matter?

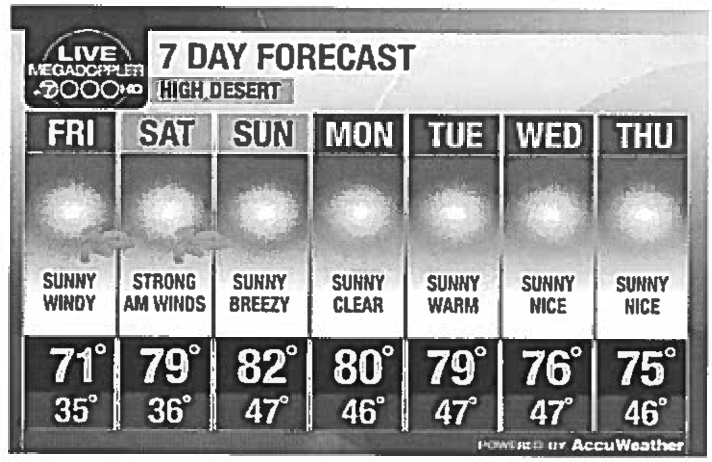


LIST 10 items that can be classified as a GAS.

Name: ______________________________

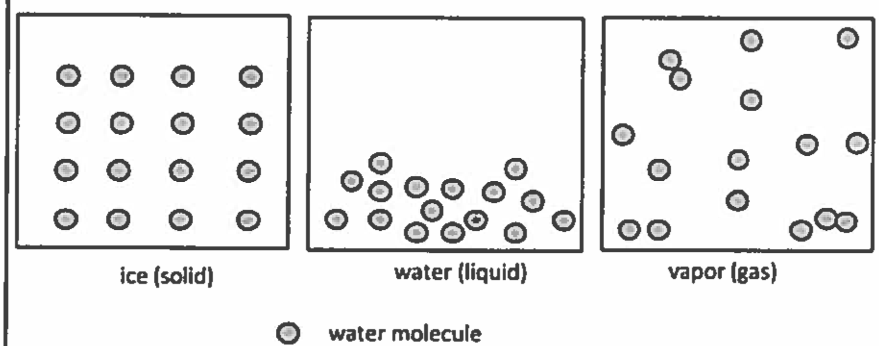
States of Matter Assessment

1. Which day's *temperature* will lead to the fastest moving molecules in a gas? How do you know?



2. After showing the different states of water (ice, water, & water vapor) in lab to the class, the teacher asked students to create a model explaining how ice, water, and water vapor are ***different***. Carl's models and description appear in the diagram below.

   Describe what is good and what might be improved about Carl's models in explaining how the three states of water are different in the arrangement of their water molecules.



The different states of water molecules are arranged differently. In a solid, the molecules are more organized. In a liquid, the molecules are not as organized as a solid. In a gas, the molecules are not as organized as a liquid.

GOOD (4)	CAN BE IMPROVED (4)
1.	1.
2.	2.
3.	3.
4.	4.

Name: ______________________

3. One ***cold*** morning, Jane went to the gym to get a ball. She noticed that the ball felt a little bit flat when she squeezed it. She left the ball outside while she went to school. By the time she got got back home it was ***hot*** and sunny outside. When Jane got home she picked up the ball and squeezed it, she noticed that the ball seemed more inflated (pumped up) than it did when it was the morning. She wondered why the ball seemed more inflated after school in the hot sun even though she did not fill it up with air.

PART 1: Draw a diagram that shows Jane why the ball was more inflated outside on a ***hot sunny*** day and why it was more flat on a ***cold*** morning. She did not add any air to the ball!

PART 2: Once you have completed your drawing, explain to Jane why the ball was more inflated outside on a ***hot sunny*** day and why it was more flat on a ***cold*** morning.

Cold Morning

Hot Afternoon

4. Create a model of what happens to the dry ice during sublimation (a phase change). Show what happens BEFORE the phase change and what happens AFTER the phase started changing.

Here is some information to help with your model/explanation:

- Room temperature : 25°C
- Sublimation point of dry ice: -56.6°C

<u>**For full points, your model (drawing) will:**</u>

- ❑ Show dry ice as individual particles
- ❑ Identify dry ice's state of matter BEFORE and AFTER the phase change started
- ❑ Show glass beaker as part of the system
- ❑ Demonstrate spacing between the particles and particle motion of dry ice in two different states
- ❑ Show the energy transfer occurring to cause this phase change to occur

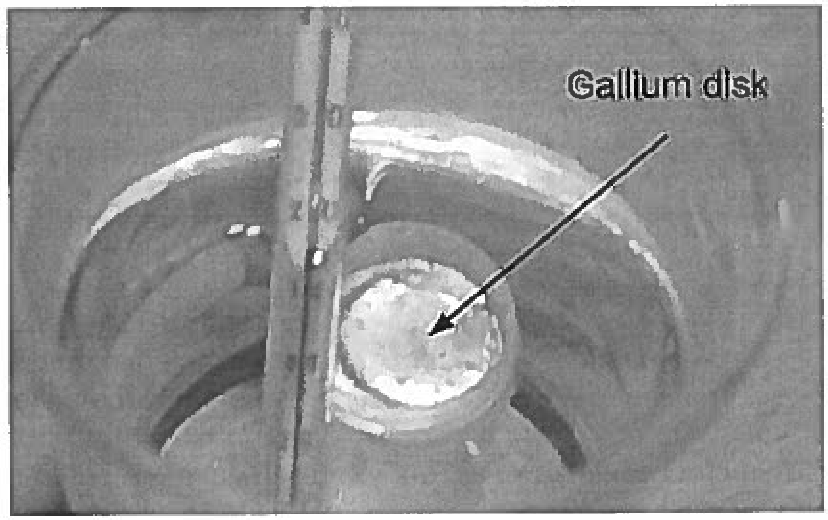
TASK PROBLEM:
(1) Develop a model that shows how a pure substance, gallium, undergoes a phase change.
(2) Construct an explanation for how the increase in thermal energy caused the phase change.

Below is a picture of a pure metal desk made of the element, gallium. The disk was placed into a beaker where the water has been heated to a temperature of 40℃.

You will also watch a video to see the phase change take place.

In addition, here is some information to help with your model and explanation:

- Room temperature : 25℃
- Melting point of gallium: 30℃
- Boiling Point of Water 100℃



Your model will:

- ☐ Show gallium as individual particles
- ☐ Identify gallium's state of matter BEFORE and AFTER the phase change
- ☐ Show water and glass beaker as part of the system
- ☐ Demonstrate spacing between the particles and particle motion of gallium in two different states
- ☐ Show energy transfer between two objects

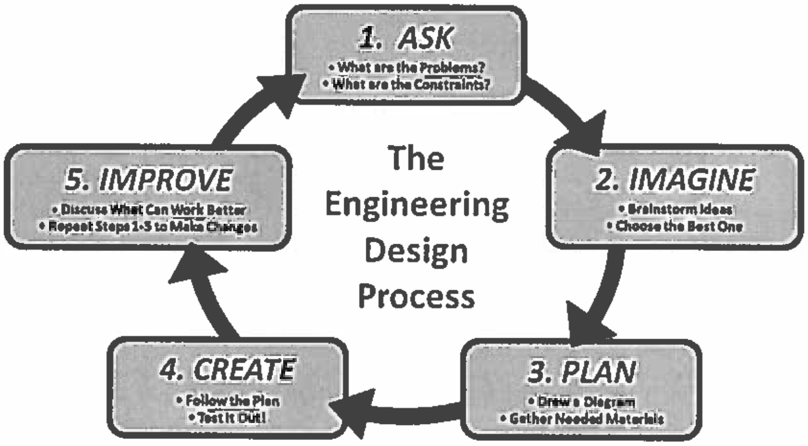
Your explanation will:

- ☐ Explain how the transfer of energy between two objects caused a phase change
- ☐ Explain differences between water and gallium caused by an increase in thermal energy

PROBLEM and INTRODUCTION Task Card
Desalination Engineering

TASK PROBLEM:

- —Design a desalination device that improves the original design
- —Test the device for purity of water and amount produced
- —Write an evidence-based argument to explain how you would revise the design after testing



Read me!!! Before you design your desalination device, let's take a look at another student's device to see if we can revise the design to make the device better. Nicholas Kinsman was interested in inventing **solar-powered devices** to reduce our nation's dependence on other energy sources. Nicholas set out to build a simple, inexpensive device to desalinate *seawater*, using readily available materials and easy construction methods for a science project.

Nicholas's first design for a desalination device is shown in Figure 1. His design did not go so well and collected very little water. Like any good inventor, Nicholas did not let an initial setback discourage him. He analyzed what was wrong with the design and set out to improve it.

In this environmental engineering task, you will build desalination devices that improve Nicholas's design to capture as much freshwater as possible.

Figure 1. This was Nicholas's first try at a solar-powered desalination device with saltwater starting in the eight small bottles. (Photo from Nicholas Kinsman's display board at the fair.)

For your device, you will:

- ❑ Construct a labeled diagram of the design, including all materials
- ❑ Demonstrate how the design uses energy and phase change to desalinate water
- ❑ Show evidence of data collection for the device being tested
- ❑ Identify the strengths and weaknesses of each solution relating to the criteria and constraints

Your explanation will:

- ❑ Describe an optimized solution that addresses as many of the criteria and constraints of the task as possible
- ❑ Cite evidence from testing and evaluation of different designs
- ❑ Explain the reasoning behind structural and material decisions
- ❑ Describe the rationale for which criterion is given highest priority if tradeoffs must be made

Focus Question: How can a device use phase changes to turn saltwater fresh with sunlight?

Can Solar Desalination Slake [Satisfy] the World's Thirst?

Turning saltwater fresh with sunlight could help an increasingly thirsty world

Ever wonder with all the seawater available in the world why are people looking for new sources of water? Seawater is not suitable for drinking nor for watering most plants due to the salt. If you were to drink seawater, your body would actually lose water, because the high salt concentration of the seawater drives water out of your cells. **Desalination** is the process of removing the dissolved salts from water, making it **pure** enough for drinking or irrigation. Solar desalination is a technique that uses solar energy to drive evaporation, remove salt from the water, and capture the resulting steam. The steam is in turn cooled and condensed into pure freshwater. Salt and other impurities are left behind. An example of a device that uses solar desalination is shown in Figure 1.

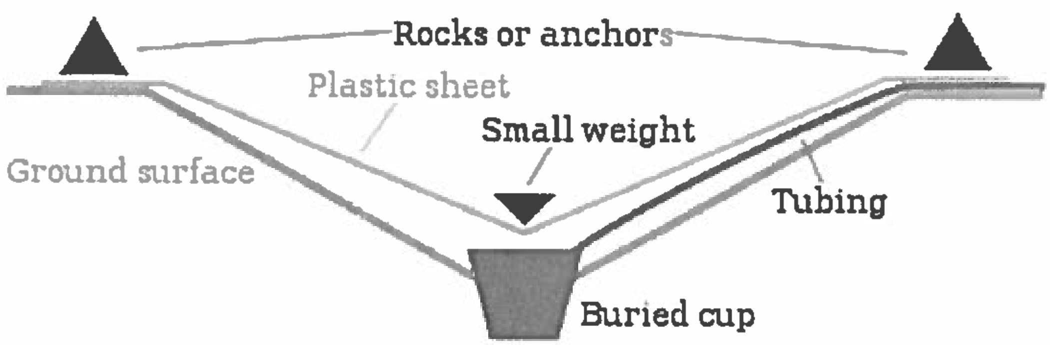


Figure 1. "Evapo still" diagram using solar energy to desalinate water. [Credits: Smack (UTC) & Happyrabbit (UTC)]

This solar still, shown in Figure 1, gets water from the ground, and lets sunlight shine through a clear plastic sheet to drive evaporation. The pure water vapor from the ground condenses on the cool plastic sheet and drips down from the weighted low point into the buried cup, where it is collected and removed. The basic principles of the solar still are simple, yet effective, as this replicates the way nature makes rain. The sun's energy heats water to the point of evaporation. As the water evaporates, water vapor rises, condensing on a surface for collection. This process removes impurities, such as salts and heavy metals, and eliminates microbiological organisms. The end result is clean water.

Less than one percent of the world's desalination is powered by renewable energy sources today, but that could all change soon if companies like California-based WaterFX have anything to say about it. Its Aqua4 "concentrated solar still" (CSS) uses a concentrated solar thermal collector to compress heat, create steam and purify water at 30 times the efficiency of natural evaporation. It can produce 65,000 gallons of freshwater per day—and it can desalinate a wide range of water sources, not just seawater. See figure 2 below.

Solar Powered

Solar thermal troughs enable low to no fuel consumption, making Aqua4™ cost-competitive with natural freshwater.

Proven Technology

Aqua4™ is fully automated, scalable, and can treat a wide range of water qualities.

Freshwater Solution

Aqua4™ produces over 200 acre-feet/year of freshwater per acre of solar collection area, making it the most efficient treatment available.

Figure 2. Images of the Aqua4 solar still which is being billed as "a proven technology for optimizing freshwater production from any source of treatable water." Taken from waterfx.co site.

The company will start employing solar desalination to treat some 1.6 billion gallons of salt-laden water drained from California's drought-stricken, agriculturally-rich Central Valley in 2016. Plant crops extract nearly pure water from soil, leaving behind salt and other potentially toxic minerals like selenium that naturally occur in the water. "If we don't start removing the salts now, at least 10 percent of all current farmland in production in California will have to be retired, and in many scenarios this number could be up to 30 to 40 percent, especially on the west side of the Valley where the salinity (salt content) is very high," says WaterFX's Matthew Stuber. "Water in the drainage areas will contaminate underground water and other waterways at an accelerated pace, eventually polluting sources of drinking water and the natural environment. Once that is released into the environment, you severely damage the natural habitat and wildlife."

Another large-scale solar desalination project is currently under construction in Saudi Arabia and scheduled for completion in early 2017. The plant is slated to produce 60,000 cubic meters (about 16 million gallons) of water per day for Al Khafji City in North Eastern Saudi Arabia, ensuring a constant water supply to the dry region throughout the year. According to Abengoa, the Spanish renewable energy company building the pioneering facility, the incorporation of solar stills would significantly reduce operating costs, as Saudi Arabia currently burns 1.5 million barrels of oil per day at its desalination plants, which provide 50-70 percent of its drinking water. Total desalination demand in Saudi Arabia and neighboring countries is expected to reach 110 million cubic meters (about 20 billion gallons) a day by 2030.

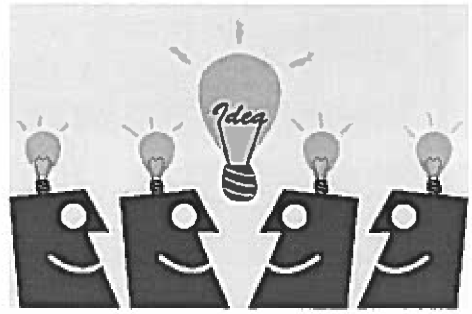
With freshwater supplies becoming scarce and in high demand due to climate change, there has never been a better time for solar desalination to come of age. Whether or not this emerging technology can go mainstream sooner than later may mean the difference between a peaceful future and one wracked by conflict over access to ever-dwindling supplies of freshwater.

Adapted from Scientific American, Science Buddies and Wikipedia

TASK PROBLEM:

- —Design a desalination device that improves the original design
- —Test the device for purity of water and amount produced
- —Write an evidence-based argument to explain how you would revise the design after testing

PART ONE - Whiteboard Brainstorm:



1. Look back at the design criteria (what you want to accomplish) and constraints (what you cannot do) you generated as a class in your notebook. Keep them in mind when generating ideas
2. Look at the different materials you can use to build your device.
3. Brainstorm design ideas for your device on a whiteboard.
   a. Divide the whiteboard in two.
   b. Draw two designs- pictures with labels (try to limit words)
   c. Remember, there is NO TALKING during this step. Your brainstorm should show evidence of: (1) Quantity over quality, (2) Build on other's ideas, (3) Suspend judgment, and (4) Wild is wonderful.

4. Be prepared to explain your ideas to your group.

PART TWO - C-Scripting:

Use the following rubric and instructions to share ideas and decide upon a design.

Decision Making:	Points Possible	Self Score	Teacher Score
❑ Each member contributes their ideas.			
❑ All members encourage each other to participate.			
❑ When there is disagreement, members express their concerns respectfully before choosing to write an idea down.			
❑ The group identifies the best solutions that everyone can live with.			

1. In groups, pass your drawing to the right (clockwise at tables).
2. Review your group member's design. Using another color marker, you may add to their idea, but you CANNOT cross out their idea. Place a checkmark (✓) next to any idea that you think is important for a great design. Remember, there is no talking or explaining.
3. Keep passing designs until you get back your original design.

4. Bring your whiteboards together in the center of the table.
5. Each person will describe one of their ideas to the group, making sure to explain why they chose each consideration.
6. Teammates discuss the parts of the design that they should be included in the final design.
7. If there is disagreement, the team discusses the idea until there is agreement/consensus.
8. Go around until all ideas have been shared.

PART THREE - Device Design

1. On the DESIGN group output sheet, bring together the group's ideas you agreed upon and develop the model for your device.
2. In order to begin building the prototype with materials, you must first finish your design with all details necessary and have it approved by the teacher.

Team Name: ______________________ Period: ____ Date: ________

Group members: ______________________________

7.1.S

DESIGN Output Sheet
Desalination Engineering

Design #1:

In the space provided below, sketch your desalination device. Use labels to describe the materials you will be using.

TASK:

- Design a desalination device that improves the original design
- Test the device for purity of water and amount produced
- Write an evidence-based argument to explain how you would revise the design after testing

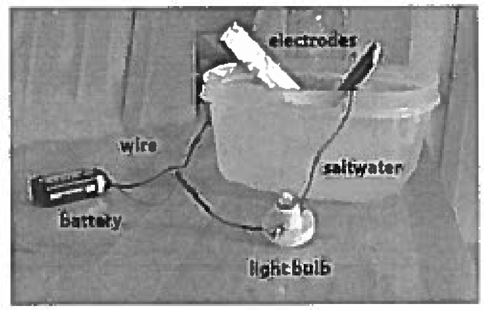
PART ONE - Testing and Collecting Data

1. Test your device for at least four hours.
2. While your device is being tested, your team will complete two things:
   a. **Modeling:** Create a model that explains how your device uses solar energy to change saltwater into freshwater. Include written explanations of observable and <u>un</u>observable changes (before and after) and energy transfer. Use the ***Modeling Task Card*** to guide your modeling.
   b. **GROUP - Visiting Other Teams:** While your desalination device is working, visit three other teams and compare your design to theirs. Answer the following prompts for EACH TEAM you visit in your notebook:
      i. **TEAM #_____**
      ii. Team member names:
      iii. List three differences between their design and yours.
      iv. Do you think their design will work? Explain why or why not.

TASK:

- Design a desalination device that improves the original design
- Test the device for purity of water and amount produced
- **Write an evidence-based argument to explain how you would revise the design after testing**

PART ONE - Data Collection and Analysis



1. Afterwards, make sure to collect and record the following data in your notebook. Clean up your area.
   a. Did you collect any water? What volume of water was collected (in ml)?
   b. If you collected water, use the saltwater circuit to test the water for salt. Did the water you collected conduct electricity? How bright was the bulb?

NO LIGHT | BRIGHT LIGHT

Little to no salt present in the water | Large amount of salt present in the water

   c. If you did not collect water, how could you improve your design?
2. Have one person from your group report out the data to the whole class.

PART TWO - Discussions and Gallery Walk

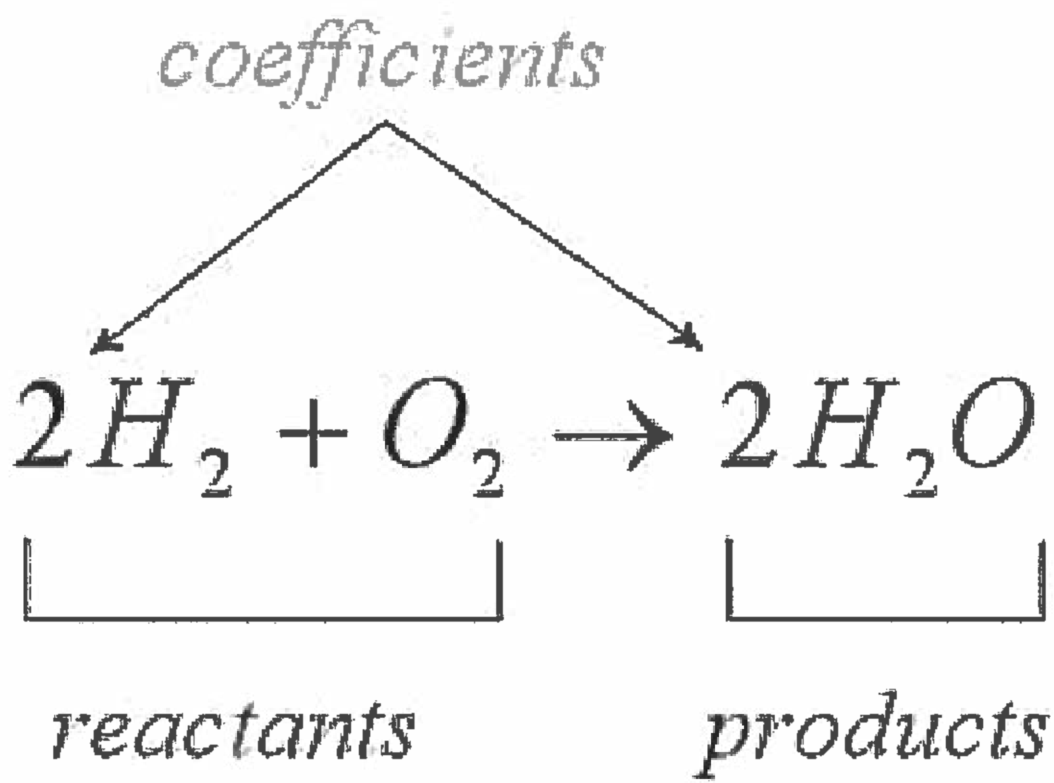
3. DISCUSSION - As a team, discuss at your table if your design was able to solve the problem and answers to the following questions. You may review the constraints and criteria for the task. Be prepared to share out your thoughts on your design.
   a. Which design criteria did your design fulfill? (Refer back to the INTRODUCTION task card)
   b. Choose a feature of your design that significantly contributed to its ability to meet the design criteria.
      i. How did you choose to incorporate this feature in your design?
      ii. What evidence can you point to that proves your device was successful in meeting the criteria?
   c. Was there a feature of your design that needs revision? How do you know you need to revise this part?

PART TWO - Individual Argument:

1. Using argumentation language, explain how you would revise the design to best meet the design criteria and follow all constraints. Support your justification with evidence and reasoning.
2. Make sure your argument:
   - ☐ Describes an optimized solution that meets all of the design criteria
   - ☐ Describes a solution that follows all of the design constraints
   - ☐ Includes evidence from multiple sources, including the data from your testing, reading, modeling, and evaluation of different designs.
   - ☐ Explains the reasoning behind structural and material decisions, including prioritizing certain criteria over others

Lathrop Intermediate

7th grade Science
Chemical Reaction Unit



7.2.0 TASK CARD - SPLITTING WATER LAB

Background: Electricity is "created" when certain chemicals react together. We use chemically- made electricity to power many machines from flashlights to a watch or sometimes a car. Yes, there are cars that run on electricity! The devices that store electricity are called batteries. Electricity can also be used to produce chemical changes.

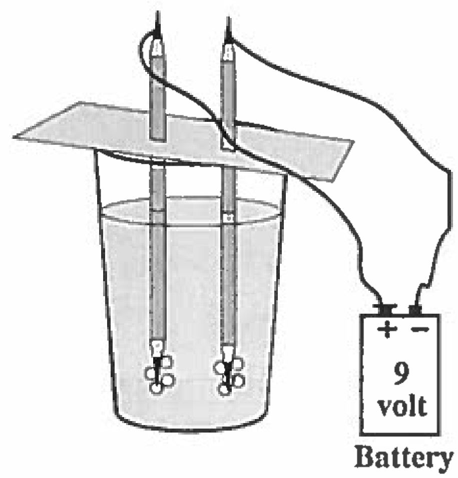
If an electrical current is passed through water between electrodes (the positive and negative poles of a battery), the water is split into its two parts: oxygen and hydrogen.

INPUT: Pre-lab Practice and Questions

What do you think you will observe when you run electricity through water?
Collect as much data as you can.

Materials:

- 1 beaker
- water
- 1 Teaspoon of Salt
- Cardboard
- 2 pencils
- 2 pieces of copper wire
- 9V battery
- Popsicle stick or spoon



Procedure:

1. Fill a beaker ¾ fill of water (from the sink). Add three pinches of salt to the water in the beaker and stir with the Popsicle stick until the salt is fully dissolved.

2. Take two pencils (with both ends sharpened). Poke the pencils through the piece of cardboard so that when the cardboard is placed over the beaker, the pencils extend down into the water solution. Keep the holes fairly close together *–make the holes **no more** than 1 inch apart* (use a ruler if needed!!)

3. Coil one piece of wire around the positive terminal of a 9-Volt battery and around the lead of one of the pencils.

4. Attach another wire to the negative end of the 9 Volt battery. Now touch the other end of the wire to the lead of the other pencil.

5. Watch and record what happens to the ends of the pencils that are extended into the water.

OUTPUT: Post-Lab Questions

Answer these questions in your interactive notebook.

1. Is this a chemical change? What evidence did you observe to support your claim?
2. What do you observe at the end of the pencils that are in the water? What molecules do you think these are?
3. Is there more oxygen or hydrogen being produced from splitting water?
4. What do you think would happen if we continued to let this reaction run?

Source: http://www.energyquest.ca.gov/projects/split_h2o.html

Group Work Rubric

	1	2	3	4
Contribution	One or more members did not contribute	All members contribute, but some contribute less than was required by the group	All members contribute equally.	All members contribute equally, and some even contribute more than was required.
On Task	Team needed three teacher reminders to get on task.	Team is on task some of the time. Needed two teacher reminders to get on task.	Team is on task most of the time. Needed 1 teacher reminder.	Team is on task all of the time. If done early, group waits patiently and asks teacher for additional tasks.
Communication	Group members are at a voice level 4. Members need 3 teacher intervention to listen and speak to each other appropriately.	Group members fluctuate between voice level 3 to 4. Members need 2 interventions to listen and speak to each other appropriately.	Group members are at voice level 3. All members listen and speak to each other in equal amounts.	Group members are at voice level 2-3. All members listen and speak to each other in equal amounts in friendly and encouraging tones.
Connections	Group members do not make connections from the task to science content.	Group members make 1 connection to science content.	Group members make 2-3 connections to science content.	Group members make 4 or more connections to science content.

Name: ______________________________ Period: ________ Date: __________

7.2.0 Output Sheet

Addressing Misconceptions

DIRECTIONS: The following are a list of students' answers from a test on what you learned. Each statement is considered a MISCONCEPTION because the student has incorrect ideas about the subject.

Read each response and (1) explain to the student what is their wrong idea and (2) what is the correct understanding they should have. Always use complete sentences when appropriate. Fill the spaces provided with detailed responses and highlight/underline all unit vocabulary.

1. Student A - Gwen

"Water (H_2O) and hydrogen gas (H_2) are pretty much the same since they both have an H in them."

Your response - ______________________________

____

____

____

____

2. Student B - Adem

"Water is an element made up of 1 hydrogen atom and 2 oxygen atoms."

Your response - ______________________________

____

____

____

____

3. Student C - Blake

"In our lab today, we observed two mystery liquids. Both of the liquids were clear and had no color to them. Therefore, they must be the same liquid."

Your response - ______________________________

____

____

____

____

4. Student D - Pharrell

"Both Co and CO are the same because they both have the same properties."

Your response - ______________________________

____

____

____

____

7.2.0 Task Card – Splitting Water Lab Output Sheet

Pre-lab

What do you think you will observe when you run electricity through water?

Collect as much data as you can.

7.2

Post-lab

1. Is this a chemical change? What evidence did you observe to support your claim?

2. What do you observe at the end of the pencils that are in the water? What molecules do you think these are?

3. Is there more oxygen or hydrogen being produced from splitting water?

4. What do you think would happen if we continued to let this reaction run?

7.2.1 Task Card - Physical vs. Chemical Thinking Map (Print 2 copies and place in plastic sleeves)

Guiding Question: What's the difference between a physical or chemical change?

Task List:

1. Set up a compare and contrast map
2. Independent: Read the article and take notes in your Thinking Map
3. Group: Share your notes
4. Group: Sort changes and add to your Thinking Map
5. Whole Class: Watch a video on "Physical and Chemical Changes" and add notes to your map
6. Complete steps 2-4 of Cornell Notes for Science

Directions:

1) **Independent**: Build a Compare and Contrast Thinking Map in your Interactive Notebook that fills the page so you have plenty of room to write. Label one side "Physical Change," label the middle "Both," and the other side "Chemical Change." By the end of class, your map should be highly detailed, full of factual information, and provide evidence of excellent use of class time.

2) **Independent:** Read the short article below, Gather information from the reading and begin filling out your Venn Diagram.

3) **Group:** Share your Venn Diagram with your group and compare your notes with others'. Add information as needed.

4) **Group:** In your group, read the list of changes below and determine if they are physical changes or chemical changes. Add these examples to your Venn Diagram.

5) **Whole Class:** Watch a video about "Physical and Chemical Changes" and add final notes and details to your Venn Diagram.

6) **Independent:** Go back and complete steps 2-4 of the Cornell Notes Process.

7.2.1 Task Card - Physical vs. Chemical Thinking Map (Print 2 copies and place in plastic sleeves)

Comparing Physical and Chemical Changes: Similarities and Differences

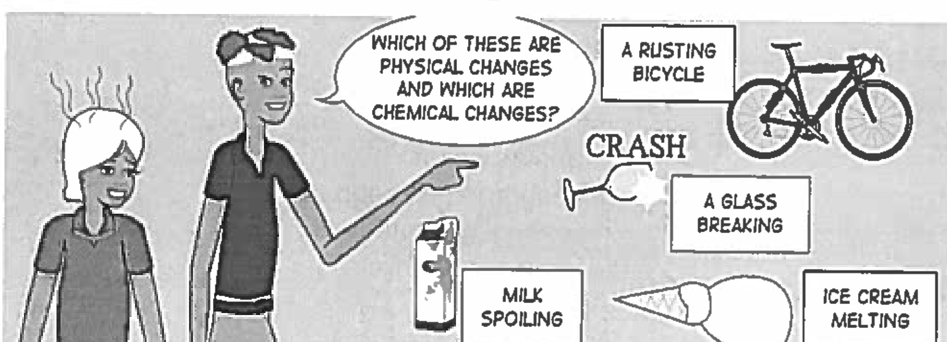
A **chemical change** is a change in matter in which one or more new substances is produced. This process is not easy to reverse. Some clues that a chemical change has taken place are a change in color, smell, or texture, the release of gas, temperature change, and/or change of state. When you burn wood, the wood is chemically changed (into ashes) by the fire. In a chemical change, molecules are broken apart and regrouped to produce new molecules with different properties. Energy is used to begin a chemical change and energy can be absorbed or released when the change occurs.

A **physical change** is a change in matter in which no new substance is produced. This is usually a change from one state to another, and can often be reversed. A good example of a physical change is water turning into ice and melting back into the liquid form again. In a physical changes, molecules are not broken apart or rearranged; only the spacing between molecules changes. Energy is needed to start a physical change, but no energy is absorbed or released when the change occurs.

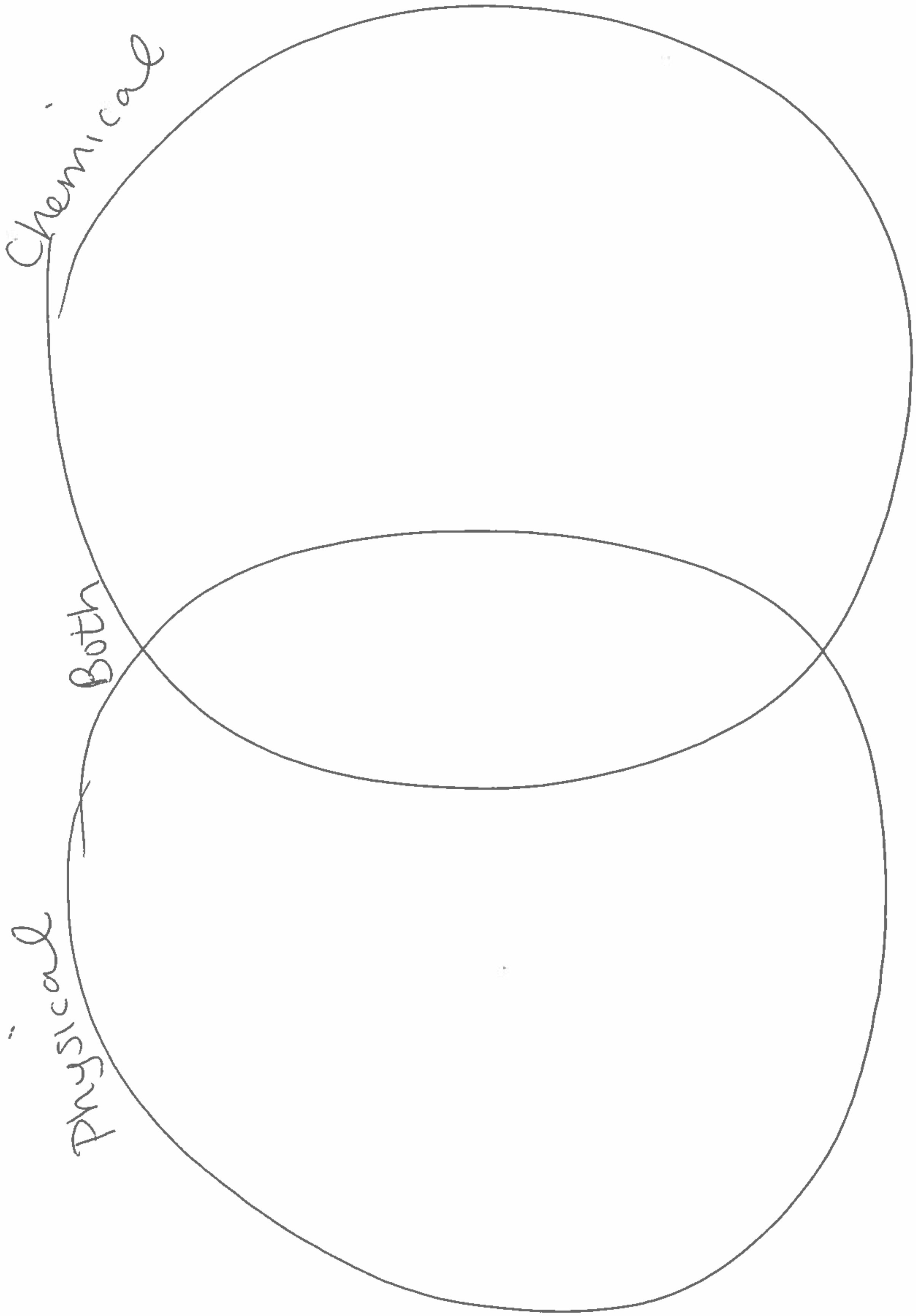
Chemical Change or Physical Change?

Using two different colored highlighters, highlight chemical changes in one color and physical changes in the other color

glass breaking
hammering wood together
rusting bicycle
separating sand from dirt
bleaching your hair
frying an egg
squeezing oranges for juice
melting ice cream
mixing sugar and coffee
milk spoiling
water evaporating
cutting grass
burning leaves
fireworks exploding
cutting your hair
crushing a can
boiling water



7.2.1



7.2.1 Task Card - Observations and Evidence for Physical and Chemical Changes (Print 2 copies and place in plastic sleeves)

Guiding Question: *How can I explain the differences between a chemical change and a physical change through observable evidence?*

You will be observing several ways in which matter interacts. Your task is to collect evidence to prove whether the interaction demonstrates a physical change or a chemical change.

Directions:

1. Copy the following data table in your notebook to help you organize your observations. The data should take up at least 2 pages in your notebook.
2. During the interactions, look for evidence of both physical and chemical changes, and complete your table with these observations.
3. After making observations and collecting evidence, make a final claim if the reaction was physical or chemical and use evidence to support your claim.

Interactions	Observations and Evidence of a Physical and/or Chemical Change	Final Claim: Physical Change or Chemical Change?
1. Crushing a Sugar Cube		
2. Burning Crushed Sugar		
3. Melting Candle Wax		
4. Burning a Candle Wick		
5. Mixing Water and Salt		
7. Iodine Clock		
8. Elephant Toothpaste		

7.2.1 Observations and Evidence

Interactions	Observations and Evidence of a Physical and/or Chemical Change	Final Claim: Physical Change or Chemical Change?
1. Crushing a Sugar Cube		
2. Burning Crushed Sugar		
3. Melting Candle Wax		
4. Burning a Candle Wick		

5. Mixing Water and Salt		
7. Iodine Clock		
8. Elephant Toothpaste		

Name ______________________________ Date ______ Period ______

Unit 2a - Learning Task #3
Student Handout - Day 4

Day 4:

Notes from Discussion on Chemical Changes:

GUIDED NOTES:

Now, let's take a closer look at two mixtures to understand what was happening at the molecular level. Write in the physical properties of citric acid observed from Day 1's data table and any new properties seen on Day 3.

Mixture	**Citric acid + Vinegar (acetic acid)**	**Citric Acid + Washing soda (sodium carbonate)**
Properties observed Day 1	Citric Acid:	Citric Acid:
New properties observed Day 3		
Change: Physical or Chemical?		
Molecular Model After Mixing (added after chemical equation)		

The mixture between citric acid and washing soda showed evidence of a chemical reaction. Scientists write chemical reactions as equations to show what happened before and after.

Here is the chemical equation:

$$C_6H_8O_7 \quad + \quad Na_2CO_3 \quad \longrightarrow \quad CO_2 \quad + \quad H_2O \quad + \quad Na_3C_6H_5O_7$$

Before Mixing	After Mixing
Citric acid and washing soda	Carbon dioxide, water and sodium citrate
$C_6H_8O_7$ + Na_2CO_3	
before the arrow →	→ arrow points toward
R______________________	P_________________________

Writing Tasks:

Now using your data from Day 1 and 3, any notes, and your infographic, do the following:

1. On the infographic from Day 2, add notes to show what happens at the molecular level for a chemical change AND a physical change.

2. Prove how you know the citric acid and washing soda mixture produced a chemical change with evidence and reasoning. Make sure you include the what happens at the molecular level. You may include labeled diagrams, but you need to explain your ideas in words as well.

Chemical Reactions and Energy

Introduction

All chemical reactions involve energy. Energy is needed to break bonds in reactants. These bonds may be very strong. Energy is released when new bonds form in the products. That's because the atoms now have a more stable arrangement of electrons. Which energy is greater: that needed for breaking bonds in reactants or that released by bonds forming in products? It depends on the type of reaction. When it comes to energy, chemical reactions may be endothermic or exothermic.

Endothermic Reactions

In an **endothermic reaction**, it takes more energy to break bonds in the reactants than is released when new bonds form in the products. The word "endothermic" literally means "taking in heat."

$$\text{Reactants} + \text{Energy} \rightarrow \text{Products}$$

In many endothermic reactions, heat is absorbed from the surroundings. As a result, the temperature drops. The drop in temperature may be great enough to cause liquid products to freeze.

One of the most important endothermic reactions is photosynthesis. In this reaction, plants synthesize glucose ($C_6H_{12}O_6$) from carbon dioxide (CO_2) and water (H_2O). They also release oxygen (O_2). The energy for photosynthesis comes from light (see **Figure** below). Without light energy, photosynthesis cannot occur. The chemical equation for photosynthesis is:

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

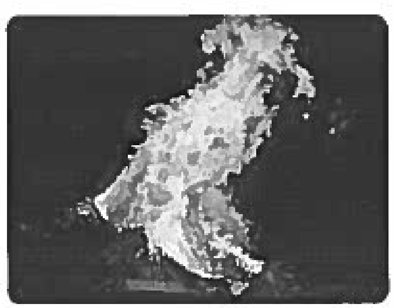
Plants can get the energy they need for photosynthesis from either sunlight or artificial light.

Exothermic Reactions

In an **exothermic reaction**, it takes less energy to break bonds in the reactants than is released when new bonds form in the products. The word "exothermic" literally means "turning out heat." Energy, is released as an exothermic reaction occurs. The general equation for an exothermic reaction is:

$$\text{Reactants} \rightarrow \text{Products} + \text{Energy}$$

Energy can be released in two main ways. If the energy is released as heat, an exothermic reaction results in a rise in temperature. Another way energy can also be released at light. Combustion reactions are examples of exothermic reactions. When substances burn, they usually give off energy as heat and light. Look at the big bonfire in **Figure** below. You can see the light energy it is giving off. If you were standing near the fire, you would also feel its heat.

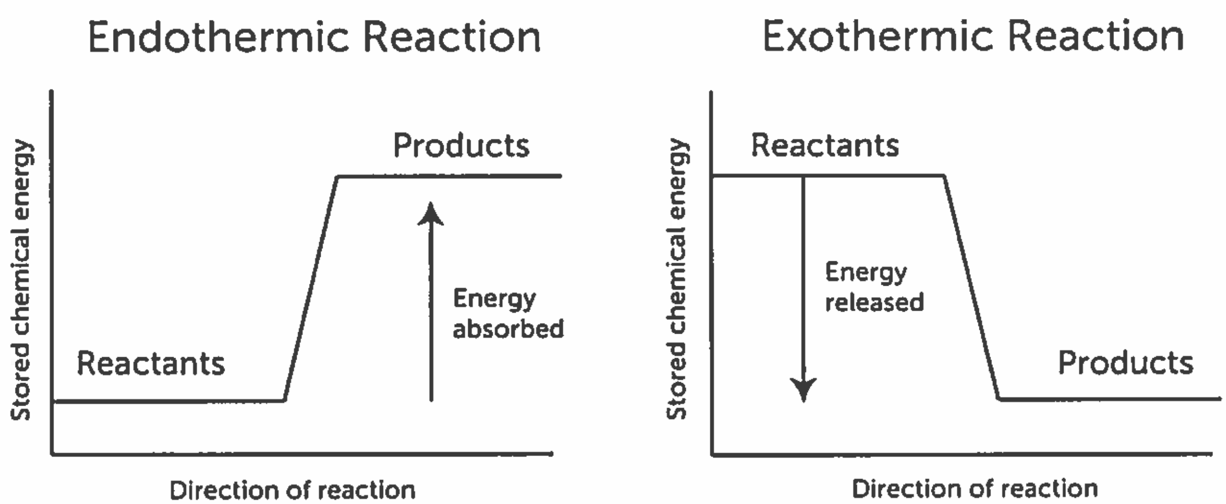


The combustion of wood is an exothermic reaction that releases energy as heat and light

Conservation of Energy

Whether a reaction absorbs energy or releases energy, there is no overall change in the amount of energy. Energy cannot be created or destroyed. This is the **law of conservation of energy**.

If energy cannot be destroyed, what happens to the energy that is absorbed in an endothermic reaction? The energy is stored in the chemical bonds of the products. This form of energy is called chemical energy. In an endothermic reaction, the products have more stored chemical energy than the reactants. In an exothermic reaction, the opposite is true. The products have less stored chemical energy than the reactants. The excess energy in the reactants is released to the surroundings when the reaction occurs. The graphs in **Figure** below show the chemical energy of reactants and products in each type of reaction.

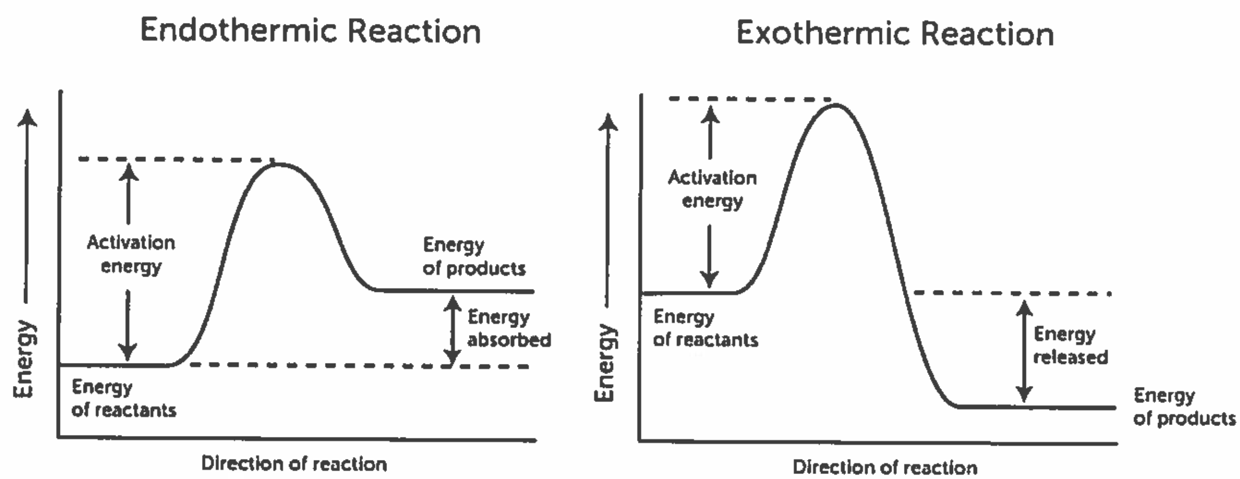


These graphs compare the energy changes in endothermic and exothermic reactions. What happens to the energy that is absorbed in an endothermic reaction?

Activation Energy

All chemical reactions, even exothermic reactions, need a certain amount of energy to get started. This energy is called **activation energy**. For example, activation energy is needed to start a car. Turning the key causes a spark that activates the burning of gasoline in the engine. The combustion of gas won't occur without the spark of energy to begin the reaction.

Why is activation energy needed? A reaction won't occur unless atoms or molecules of reactants come together. This happens only if the particles are moving, and movement takes energy.

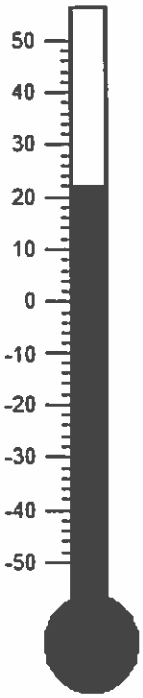


Even exothermic reactions need activation energy to get started.

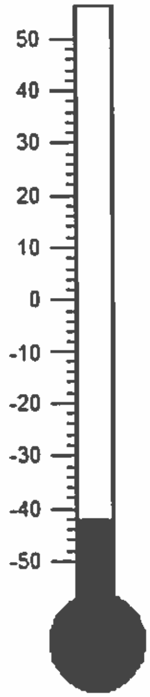
Name: ______________________________ Score: ______

Reading Thermometers

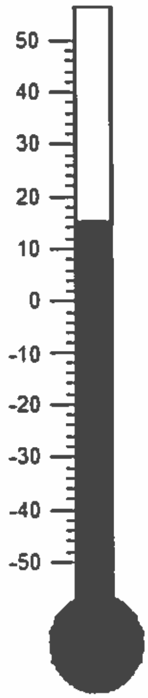
Write the temperature shown on each thermometer:

1)


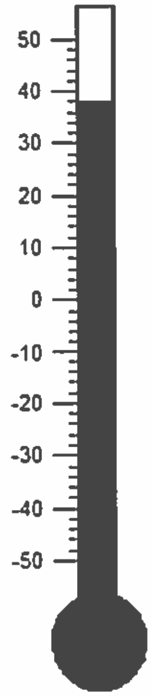
_______ °C

2)


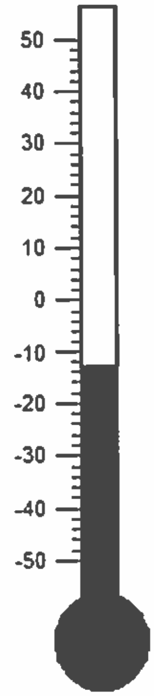
_______ °C

3)


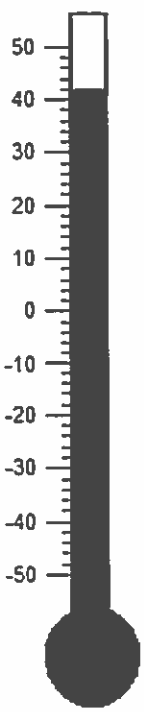
_______ °C

4)


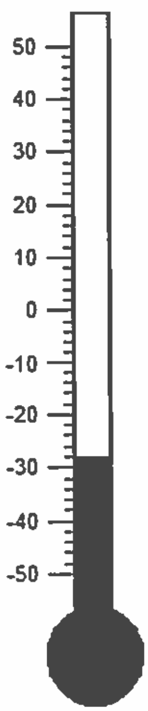
_______ °C

5)


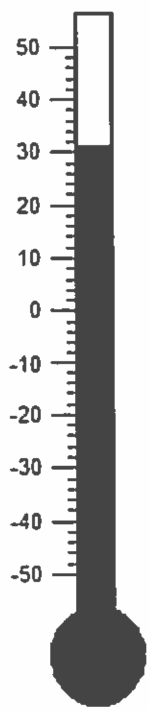
_______ °C

6)


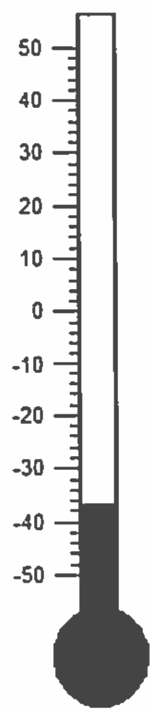
_______ °C

7)


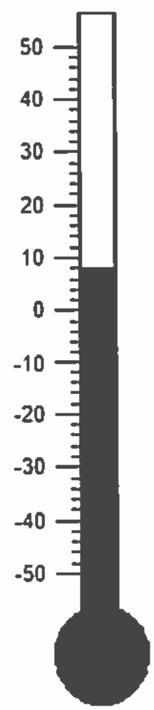
_______ °C

8)


_______ °C

9)


_______ °C

10)


_______ °C

Unit 2 - Learning Task #3 - Exothermic vs. Endothermic

Student Task Card: Ammonia and Epsom Salt

Essential Question: What evidence of a chemical change can we observe when mixing ammonia and magnesium sulfate (Epsom salt)?

Background:
Sometimes, two substances will react to form a brand new solid that does not dissolve in water. This new substance forms when the substances are mixed together and is referred to as a precipitate. In this lab, you will react magnesium sulfate (Epsom salt) with ammonia. These are both substances that dissolve in water, but react with each other to form a precipitate. The production of a precipitate is evidence of a chemical change.

Materials:
1 teaspoon magnesium sulfate (Epsom salt)
15 mL household ammonia
1 thermometer
1 timer
Plastic spoon
100 mL graduated cylinder, or dixie cup

Procedure:

1. Design a data table in your notebook to help you record observations, temperature, and collect evidence of chemical changes throughout the experiment.
2. Add 1 tsp of epsom salt to the graduated cylinder using a scrap piece of paper as a funnel (see image).
3. Carefully drop the thermometer into the graduated cylinder and record the temperature.
4. Add 15 mL of ammonia to the flask (shake gently to mix). CAUTION: ammonia has strong fumes, be careful not to breathe the fumes.
5. Record the temperature.
6. Continue to record the temperature every 2 minutes for a total of 10-20 minutes (your teacher will decide).
7. In your data table, record all observations and evidence of chemical changes.
8. Dispose of solution down the sink. Rinse your equipment well.
9. Complete the Student Output Sheet.

Unit 2 - Learning Task #3 - Exothermic vs. Endothermic

Student Task Card: Orange Juice and Baking Soda

Essential Question: What evidence of a chemical change can we observe when we mix orange juice and baking soda?

Materials:
25 mL orange juice
15 g baking soda
1 Styrofoam cup
1 Thermometer
1 Timer
1 Spoon or stir rod

Procedure:

1) Read through the procedure carefully and design a rough draft of a possible data table with your group members that will help you organize your temperature data, and observations.
2) Once the data table is approved by your teacher, each student should create a copy of the data table in their notebooks.
3) Pour the orange juice into the styrofoam cup.
4) Place the thermometer in the cup for 2 minutes and record the initial temperature.
5) Stir in the baking soda (Sodium Bicarbonate) and take temperature readings every 30 seconds for a total of 5 minutes.
6) In your data table, record all observations and evidence of chemical changes.
7) Record the temperature readings and observations accurately in your data table.
8) Wash and dry your supplies, return them to your teacher.
9) Complete the Student Output Sheet.

Unit 2 - Learning Task #3 - Exothermic vs. Endothermic
Student Task Card: Steel Wool & Vinegar Reaction

Essential Question: How can I collect and organize data to determine if a reaction is endothermic or exothermic?

Introduction:
Exothermic chemical reactions produce heat. In this reaction, vinegar is used to remove the protective coating from steel wool, allowing it to rust and exposing iron. When the iron combines with oxygen, heat is released. Not only does the vinegar remove the protective coating on the steel wool, but once the coating is off its acidity aids in oxidation (rust) of the iron in the steel.

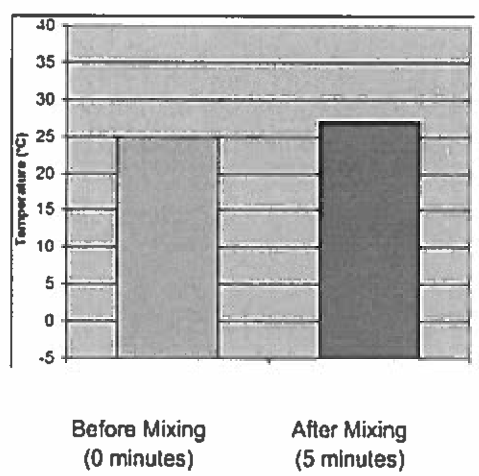
Materials for the Experiment:

- 1 piece of Steel Wool
- ¼ cup (60mL) of Vinegar
- Jar with lid
- 1 Clock, watch, or timer
- Thermometer

Instructions:

1. Design a data table with your lab group that will help you collect and organize the temperature, observations, and sketch of the equipment set-up both before mixing the wool and vinegar, and 5 minutes after mixing.
2. Place the thermometer and steel wool in the jar and close the lid. Wait 5 minutes.
3. Add a sketch of the equipment set-up to your data table.
4. Record your observations.
5. Then open the lid and read the thermometer. Record the temperature in your data table.
6. Remove the thermometer from the jar (if you didn't already in Step 1).
7. Soak the steel wool in the vinegar for 1 minute.
8. Squeeze the excess vinegar out of the steel wool.
9. Wrap the wool around the thermometer and place the wool/thermometer in the jar, sealing the lid.
10. Add a sketch of the equipment set-up to your data table.
11. Allow 5 minutes, then open the jar, unwrap the wool and read record the temperature in your data table.
12. Record the temperature, observations, and sketch of the equipment set-up before and 5 minutes after mixing in your data table.
13. Create a bar graph on the Student Output Sheet: Steel Wool to show the temperature of the steel wool before and after mixing. (Be sure to label and number the axes).

Sample Bar Graph



Unit 2 - Learning Task #2 : Heat and Rate of Reaction

Student Task Card: Glow Sticks in Ice Water vs. Hot Water

Essential Question: How does warming or cooling affect the rate of a chemical reaction?

Materials for the Experiment

- Hot water in a clear glass or beaker
- Ice water in a clear glass or beaker
- 2 glow sticks (same color for easy comparison)

Procedure

1. Create a data table in your notebook to record your observations of the glow sticks in the hot and cold water.
2. Answer the prediction question BEFORE starting the experiment (see next page).
3. Place one glow stick in hot water and another in ice water *(Note: DO NOT break or "pop" the glow sticks).*
4. Soak the glow stick in the water for a few minutes.
5. Write your predictions in your notebook.
6. Remove the glow sticks from both the hot and cold water and bend and "pop" the glow sticks.
7. Return the glow sticks to the correct cups and record observations.

Unit 2 - Learning Task #2 : Heat and Rate of Reaction

Student Task Card: Glow Sticks in Ice Water vs. Hot Water

Lab Analysis and Conclusions

Directions: Answer these 6 questions in complete sentences and using unit vocabulary in your science notebook:

PREDICTION

BEFORE the experiment:

1) Before bending or "popping" the glow stick to activate it, what do you think will happen to the glow stick in the hot water? In the cold water?

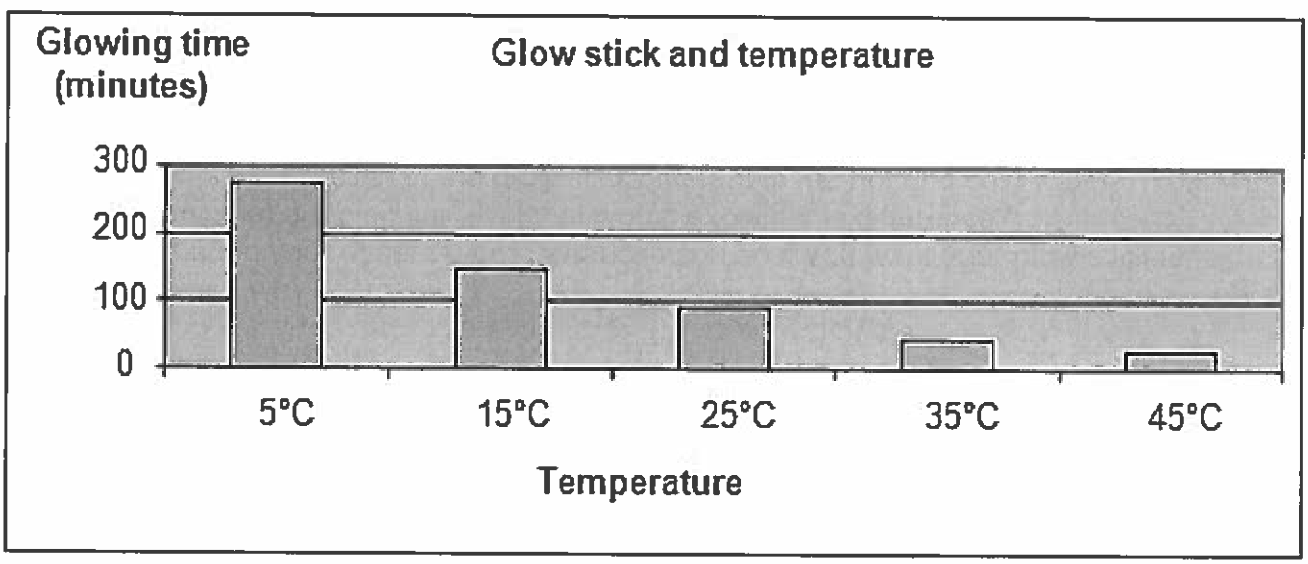
CONCLUSIONS

AFTER the experiment:

2) Using unit vocabulary, explain what happens when you bend or "pop" a glow stick.
3) How was the reaction in the glow stick different in the hot and cold water? What was happening at a molecular level that would explain this difference?
4) Based upon your observations, what can you do if you want your glow stick to last longer and why?

Reading and Interpreting graphs:

5) Look at the graph below. Describe the design of the experiment summarized by this graph. What data was collected from the experiment?
6) What conclusions can you draw from this graph?



This graph was created from data collected in a glow stick experiment.

SAUSD SCIENCE
ADAPTED FROM OUSD

7.2.4 Task Card: Changes and Energy - Day 1 & 2 (Print 2 copies and place in plastic sleeves)

Guiding Question: *How can you track energy in a system?*

Design an experiment to get the highest increase in temperature after 5 minutes from the steel wool and vinegar investigation

DAY 1:

1. **GROUP - DESIGN AN EXPERIMENT THROUGH THE VARIABLES**
   Decide which thing you could change from the experiment to test as your independent variable. We will all measure temperature of the wool as our dependent variable. You will decide the important constants (be specific).

   MATERIALS:
   - Steel wool
   - Vinegar
   - Container
   - 1 clock, watch or timer
   - Thermometer

2. **GROUP - DEFINE THE QUESTION**
   Define the question your group will help answer through this investigation.

3. **GROUP - DESIGN THE PROCEDURES**
   Decide steps that are clear and easy to follow in sequential order. Use the previous steel wool and vinegar investigation as a guide.

4. **INDIVIDUAL→ GROUPS - DESIGN A DATA TABLE**
   On your own, use the variables to design a data table that will organize essential data using the variables. It will be peer reviewed and revised. Each student will turn in their own data table and explanation.

DAY 2:

5. **CONDUCT EXPERIMENT AND COLLECT DATA**
   Conduct your experiment and collect data in your data table. Share data onto a class data table.

7.2.3 Resource Sheet: Steel Wool & Vinegar Reaction

Focus Question: *How can I collect and organize data to determine if a reaction is endothermic or exothermic?*

Background Information:
Exothermic chemical reactions produce heat. In this reaction, vinegar is used to remove the protective coating from steel wool, exposing the iron and allowing it to rust. When the iron combines with oxygen (rusting), heat is released. Thus, the reaction is between the solid iron in the steel and the oxygen gas from the surrounding air, NOT with vinegar. However, the vinegar's acidity does help speed up the oxidation (rusting) of the iron.

Materials:
- 1 piece of Steel Wool
- ¼ cup (60mL) of Vinegar
- Container (Jar and lid)
- 1 Clock, watch, or timer
- Thermometer

INPUT + PROCESSING - Procedures:	**Annotations:** Connections, questions, and summarize
1. Gather materials. 2. Place the thermometer and steel wool in the container and close the lid. Wait 5 minutes. 3. Record your observations. 4. Then open the lid and read the thermometer. Record the temperature in your data table.	
5. Remove the thermometer from the jar (if you didn't already in Step 1). 6. Soak the steel wool in the vinegar for 1 minute. 7. Squeeze the excess vinegar out of the steel wool. 8. Wrap the wool around the thermometer and place the wool/thermometer in the jar, sealing the lid.	
9. Allow 5 minutes, then open the jar, unwrap the wool and read record the temperature in your data table. 10. Record the temperature and any observations. 11. Clean up procedures:	

Preparation before the lab:

a. Design a data table with your lab group that will help you collect and organize the temperature and observations before mixing AND after mixing.
b. Sketch the procedures in your notebook for steps 2, 6, and 8.

Task Card: INTRODUCTION
Dub Nation Rehabilitation

FOCUS QUESTION

How will your group design a device to help heal an injury through heating or cooling?

TASK:

As a chemical engineer, you are hired by the Angels Baseball Athletic Department to help their team with future injuries. You are asked to (1) design a device to either cool/heat an area of the body by producing the greatest temperature change from a chemical reaction.

Each engineer will also: (2) write an individual report to argue for which chemicals they chose to use in their device and (3) model what happens to those chemicals to produce the temperature change.

Part ONE - Exploring Hot and Cold Packs

1. The cold and hot packs you saw each contain a solid substance and water. What do you think is the process that happens inside a cold or hot pack when it is activated? Answer this in your notebook. Discuss with your group.

2. Your teacher opened the cold and hot packs and showed you what was inside each. Then your teacher mixed a small amount of the solid substance from each pack with water. Copy the table into your notebook and record your observations.

What happened as each solid substance is dissolved in water?

Substance from the...	Did the temperature of the substance *increase* or *decrease?*	Is this process *endothermic* or *exothermic?*
Hot Pack		
Cold Pack		

7.2.S - Resource Sheet

Strains and Sprains

If you're an active person, you'll probably get a sprain or a strain at some point. They're common injuries, especially for people who play hard or are into sports. Let's find out more about them.

What Are Strains and Sprains?

Muscles contract and relax (almost like rubber bands) to help your body move. So a strain is exactly what it sounds like: a muscle or tendon (tissue that attaches muscle to bone) that has been stretched too far. It's common for people to strain the muscles in their backs, necks, or legs.

Bones meet at joints, such as elbows, knees, or shoulders. That's where your body bends and rotates. Strong, elastic bands of tissue called ligaments hold bones together in the joints. A sprain happens when those ligaments have been overstretched (mild sprain) or torn (severe sprain). Ankles, wrists, and knees sprain easily.

How Is a Strain Different From a Sprain?

A strain, which is an injury of the muscle or tendon, may start to hurt immediately or several hours later. The area will be tender and swollen and might also appear bruised. Someone with a strain may notice weakness or muscle spasms in the area.

A sprain, which is an injury of a ligament, will probably start to hurt right away. Usually the injury will swell and look bruised, it may be hard to walk or move the injured part, and you might even think you have broken a bone.

How Does a Strain or Sprain Happen?

Strains often happen when you put a lot of pressure on a muscle or you push it too far, such as when lifting a heavy object. Strains may be more likely to happen if you haven't warmed up first to get blood circulating to the muscles. They're also common for someone returning to a sport after the off-season. That first time playing softball after a long winter off might lead to a strained calf or thigh muscle.

Sprains are caused by injuries, such as twisting your ankle. This kind of injury is common in sports, but can also happen any time you trip or fall.

What if I Get a Strain or Sprain?

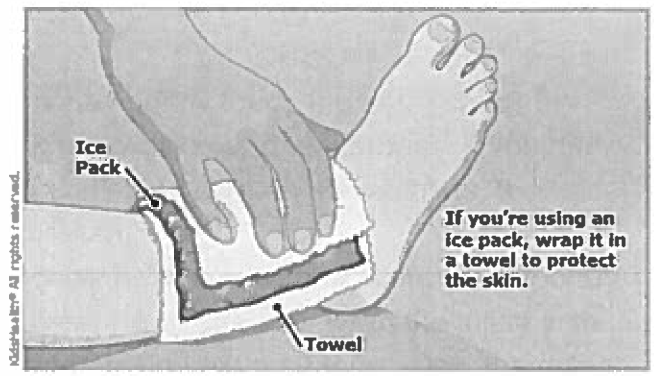
If you get a strain or sprain, try not to use the part of your body that's hurt. That means not walking on a hurt ankle or using a hurt arm. It can be hard to tell the difference between a sprain and a broken bone, so it's often a good idea to see a doctor. In some cases, you might need to go to the emergency department.

What Will the Doctor Do?

First, a doctor will look at your injury. He or she may gently touch the area, check the color, feel if your skin is warm or cold, and look for swelling and tenderness. If you hurt your ankle, your doctor might ask to see if you can stand on it. In some cases, the doctor will order an X-ray to tell if the bone is broken.

- If you have a sprain, the doctor will probably have you wear a splint or temporary cast to support and protect the injured area. He or she may wrap the injury with an elastic bandage to reduce swelling and provide extra support. Also, the doctor will probably tell you to take some pain medication.
- If you have a strain, the doctor will probably tell you to rest the injury and maybe take some pain medication.

What Happens Next?



It's very important to follow your doctor's instructions. When you get home, think RICE as a way to remember how to take care of your injury:

- Rest (the injured part of the body)
- Ice (apply cold packs to the injury to help bring down swelling)
- Compression (wrap the injury firmly with an elastic compression bandage or splint to prevent and decrease swelling)
- Elevation (raise the injured part so it's higher than your heart, also to prevent swelling)

If the swelling has gone down after 24 hours, it's OK to use warm compresses or a heating pad to soothe aching muscles. Take any pain medications that have been ordered by your doctor. A mild strain takes about one week to heal, but a more severe one can take several weeks. A sprain may also take longer — as long as 4 to 6 weeks to heal or sometimes even longer. While your strain or sprain heals, take it easy and don't do anything that could cause another injury.

If you've visited the doctor for your injury, you might have a follow-up visit to make sure everything is healing just right. When you're all healed, your doctor will give you the green light to return to your favorite activities.

Taken from Kidshealth.org

7.2.S - Task Card: BRAINSTORMING AND MODELING

Dub Nation Rehabilitation

FOCUS QUESTION

How will your group design a device to help heal an injury through heating or cooling?

TASK:

As a chemical engineer, you are hired by Angels Baseball Athletic Department to help their team with future injuries. You are asked to design a device to either cool/heat an area of the body by producing the greatest temperature change from a chemical reaction.

PART ONE - Group Decision:

1. Decide whether you want your device to heal through heating or cooling.
2. Based on your decision, look at your data from the previous activity on Temperature changes in dissolving and decide which set of data you will use to help you design your device. Copy this data from either the endothermic or exothermic reactions in your notebook to help you make a decision.

PART TWO - Whiteboard Brainstorm:

1. Record the design criteria (what you want to accomplish) you generated as a class into your notebook.
2. Keep in mind the **following constraints** when deciding your design:
    - Prevents the chemicals from mixing BEFORE they are needed
    - Heats/cools rapidly
    - Needs to be portable
    - Cannot be hot/cold enough to burn the body or damage the container
    - Device must be cooled or heated ONLY by a chemical reaction
    - Chemicals must not be able to leak out
3. Brainstorm design ideas for your device on a whiteboard.
    a. Divide the whiteboard in two.
    b. Draw two designs- pictures with labels (try to limit words)
    c. Remember, there is NO TALKING during this step. Your brainstorm should show evidence of: (1) Quantity over quality, (2) Build on other's ideas, (3) Suspend judgment, and (4) Wild is wonderful.

4. Be prepared to explain your ideas to your group.

PART THREE - C-Scripting:

Use the following rubric and instructions to share ideas and decide upon a design.

Decision Making:	Points Possible	Self Score	Teacher Score
❑ Each member contributes their ideas.			
❑ All members encourage each other to participate.			
❑ When there is disagreement, members express their concerns respectfully before choosing to write an idea down.			
❑ The group identifies the best solutions that everyone can live with.			

1. In groups, pass your drawing to the right (clockwise at tables).
2. Review your group member's design. Using another color marker, you may add to their idea, but you CANNOT cross out their idea. Place a checkmark (✓) next to any idea that you think is important for a great design. Remember, there is no talking or explaining.

3. Keep passing designs until you get back your original design.
4. Bring your whiteboards together in the center of the table.
5. Each person will describe one of their ideas to the group, making sure to explain why they chose each consideration.
6. Teammates discuss the parts of the design that they should be included in the final design.
7. If there is disagreement, the team discusses the idea until there is agreement/consensus.
8. Go around until all ideas have been shared.
9. Use the Decision Making rubric above to assess your group for each category.

PART FOUR - Group Device Model

1. On the MODELING group output sheet, bring together the group's ideas you agreed upon and develop the model for your device.
2. In order to begin building the prototype with materials, you must first finish your group model with all details necessary.

7.2.S Group MODELING Output Sheet

Members' Names: ______________________

1. Develop your model on the back of this handout.
2. Make sure your model:
   - ☐ Identifies all parts of your device, including any reactants and products
   - ☐ Shows how the device will start a chemical reaction
   - ☐ Shows what happens before and after the reaction
   - ☐ Uses symbols to represent what you could not see

3. Make sure your design follows the following **constraints:**
   - ☐ Prevents the chemicals from mixing BEFORE they are needed
   - ☐ Heats/cools rapidly
   - ☐ Needs to be portable
   - ☐ Cannot be hot/cold enough to burn the body or damage the container
   - ☐ Device must be cooled or heated ONLY by a chemical reaction
   - ☐ Chemicals must not be able to leak out

Task Card: PROTOTYPING
Dub Nation Rehabilitation

TASK:

As a chemical engineer, you are hired by the Angels Baseball Athletic Department to help their team with future injuries. You are asked to design a device to either cool/heat an area of the body by producing the greatest temperature change from a chemical reaction.

PART ONE - Model 1.0 Submission and Building

1. Submit your group MODEL output sheet to the teacher before receiving any materials for your prototype.
2. Gather materials for your prototype. Use group MODEL output sheet as a guide to build your prototype.
3. Discuss how you want to collect and organize data in a data table before you actually test your prototype. Show your teacher how you will organize the data you collect before moving on to the next part.

PART TWO - Testing and Collecting Data

4. Test your prototype, making sure to collect and record data.
5. Clean up your area.

PART THREE - Data Analysis and Revision

6. As a team, discuss at your table if your design was able to solve the problem. You may review the constraints and criteria for the task.
7. Now look at your data together and answer the following:
   a. What patterns do you see in the data?
   b. What claims can you make from this data?
   c. What is your evidence?
   d. What do you think you would change about your design after testing it?
8. Add any revisions to your group MODEL output sheet in a new color.
9. Present your ideas on a poster and be ready to share your posters with others.
10. After seeing each others' designs and data, add any new ideas to your group MODEL output sheet and extend your data table for more testing.

PART FOUR - More Testing and Revision

11. You will now have time to test and revise your design.
12. Make sure your group records data and tracks any changes you make to the design on your MODEL (in different colors).
13. Clean up your area.

PART FIVE - Final Design and Prototype

14. As a group, look over your testing data and design MODEL. Draw a final group design.
15. Build your final design as a group prototype.

Angels Nation Rehabilitation

TASK:

As a chemical engineer, you are hired by the Angels Baseball Athletic Department to help their team with future injuries.

Each engineer will also: (1) write an individual report to argue for which chemicals they chose to use in their device and (2) model what happens to those chemicals to produce the temperature change.

PART ONE - Individual Argument:

1. Using argumentation language, explain why you chose the specific chemicals to use in your device to cool/heat the injury. Support your justification with data from the lab on Temperature changes in dissolving and from any data you collected during testing of your device.
2. Make sure your argument:
    - Makes a clear claim for the substances used in the design and if the reaction was endothermic or exothermic.
    - Supports claim effectively by choosing the most appropriate data from previous testing to use as evidence
    - Demonstrates reasoning that connects evidence to the claim
    - Explains how the energy change felt connects to the reactants changing

PART TWO - Individual Model

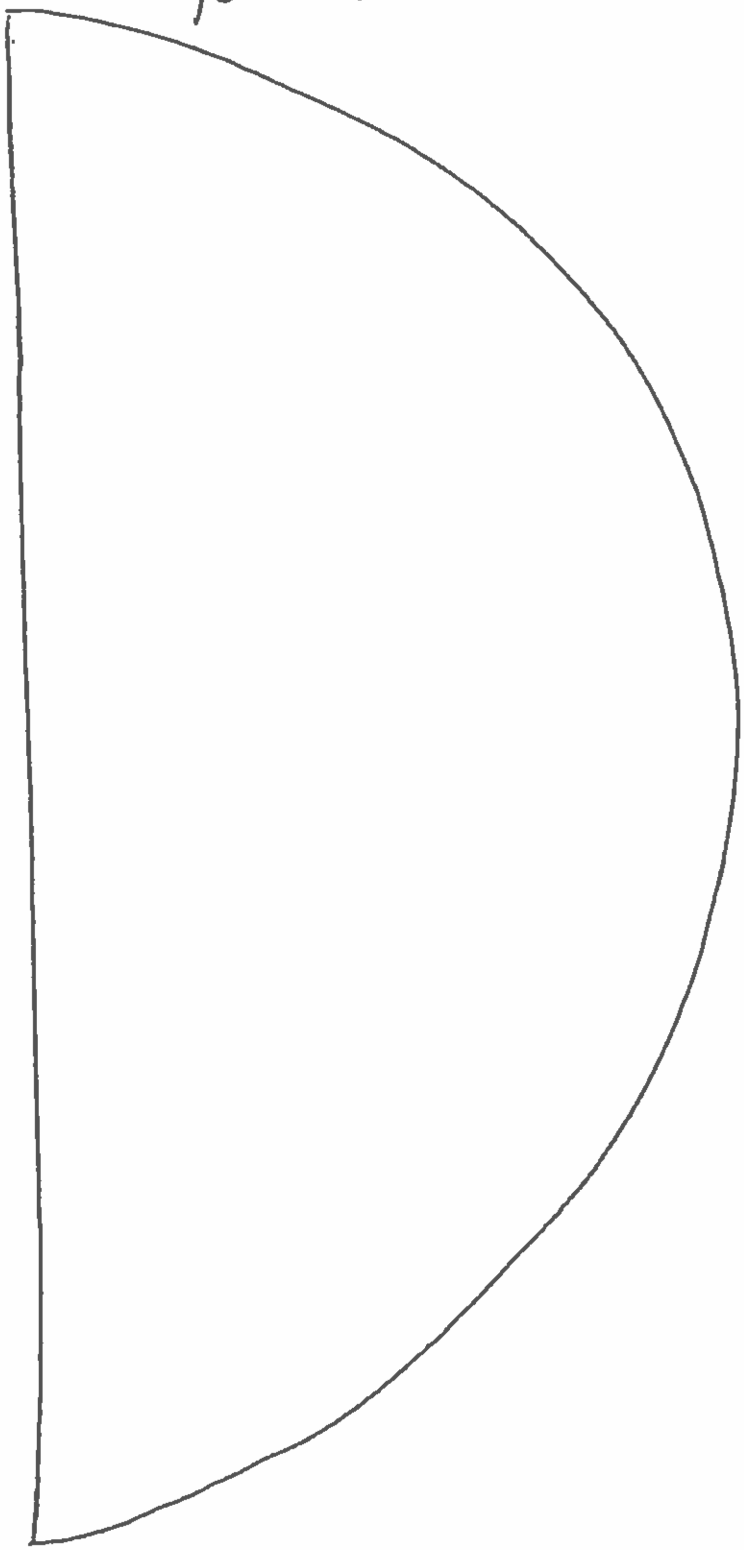
1. Develop a model that represents how the chemical reaction in your device caused a temperature change.
2. Make sure your model:
    - Uses symbols for what cannot be seen (unobservable)
    - Shows differences in energy between reactants and products
    - Includes all chemical substances before AND after the reaction
    - Demonstrates that the atoms are conserved and rearranged in the reaction

Lathrop Intermediate

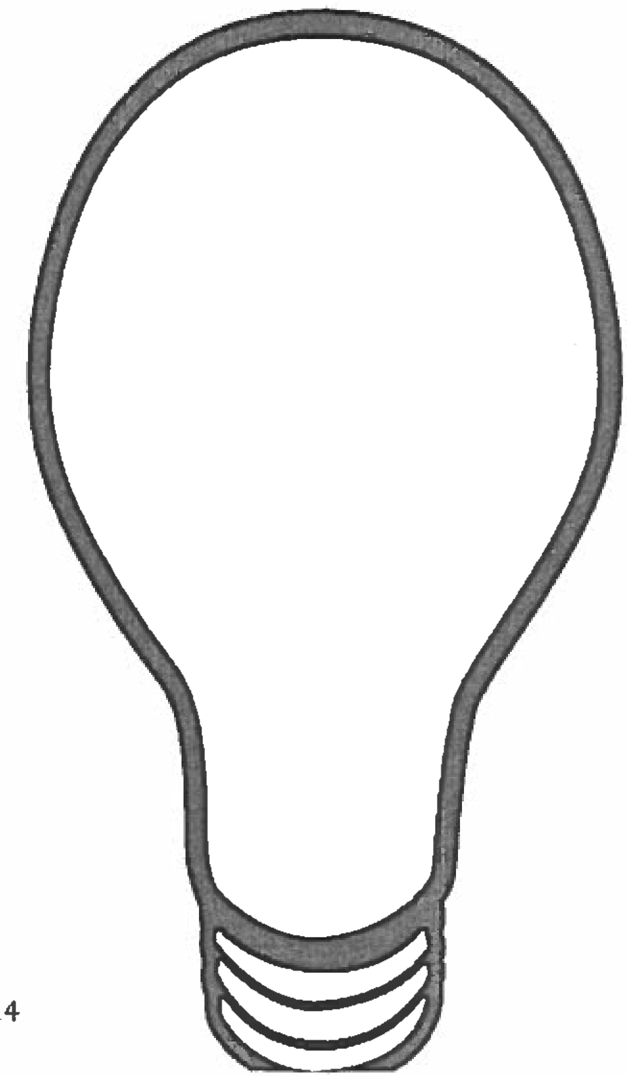
7th grade Science
Biodome Unit

Biosphere Model I

draw + label at least 3 things needed to stay alive in a biodome. Explain the items you chose.



BIG IDEA UNIT INTRO PAGE



CO_2 Generators: Yeast Investigations

Guiding Question: *What are the best conditions for yeast to perform respiration?*

The BioDome company hopes that the scientists will be able to "live typical day-to-day lives" on this mission, including growing their own food. In order for there to be a variety of food options, one possibility is for the scientists to use yeast and their ability to perform cellular respiration to make bread.

Problem:
You are a scientist researching the respiration of yeast. Your task is to recommend the best conditions for yeast to perform respiration for the breadmaking process.

You will test the amount of sugar to see its effect on the yeast's rates of respiration. Afterwards, you will analyze data given to you from your partner scientist testing the effect of temperature on the respiration rates to make your argument for the best conditions for yeast.

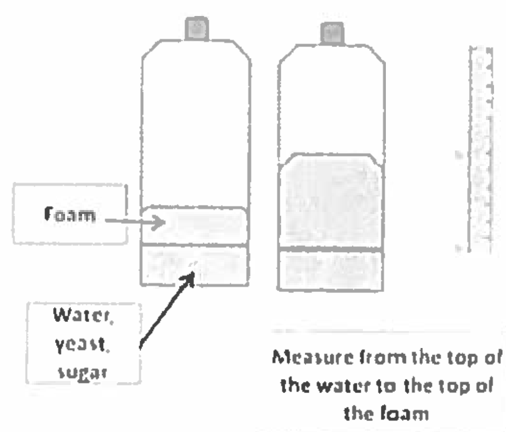
Part 1: Guided Experimentation

Focus Question: How does the amount of sugar affect yeast respiration?

Prediction: Record your prediction in the notebooks and include your reasoning.

Procedures:

1. Label each of the 3 bottles provided to your group.
    a. Low: 1 tsp
    b. Medium: 2 tsp
    c. High: 3 tsp7u
2. Measure out 60 ml of 50°C water into the 3 bottles
3. Measure the specified amount of sugar into each bottle using the funnel.
4. Measure 1 tsp of yeast into each bottle using the funnel.



5. Stir mixture in bottles with straw
6. Immediately start your timer.
7. Make initial observations and write them down.
8. Every 3 minutes measure the foam that develops on top of the water in centimeters (not the yeast, sugar and water mixture at the bottom).
9. Stop measurements at 12 minutes.

Data Table: The Effect of Sugar on Yeast Respiration Rate

Time (Minutes)	Height of Foam in Centimeters		
Temperature of water added	LOW 1 tsp	MEDIUM 2 tsp	HIGH 3 tsp
Start 0 min			
3 min			
6 min			
9 min			
12 min			

Data Table Trends:

Describe the data trend for **each bottle with a different amount of sugar** in your notebooks. Try to use words that describe change, like "increase" or "decrease" AND how quickly/slowly each changed. Be sure to use SPECIFIC numbers as evidence.

For example, ""The height of the foam in 20°C increased quickly in the beginning, but much slower the last 6 minutes. The foam started at 0.2 cm, then growing to 2 cm at 6 minutes, but only grew to 2.3 cm at 12 minutes."

Graphing:

a. Set up a graph for the data with "Height of foam in centimeters" on the Y-axis and "Time in minutes" on the X-axis.
b. Graph the data for each bottle with a different temperature on the same graph as a separate line/set of data. Make sure you have a way to distinguish the bottles with different temperatures on the graph.

CO_2 Generators: Yeast Investigations

Guiding Question: *What are the best conditions for yeast to perform respiration?*

The BioDome company hopes that the scientists will be able to "live typical day-to-day lives" on this mission, including growing their own food. In order for there to be a variety of food options, one possibility is for the scientists to use yeast and their ability to perform cellular respiration to make bread.

Problem:
You are a scientist researching the respiration of yeast. Your task is to recommend the best conditions for yeast to perform respiration for the breadmaking process.

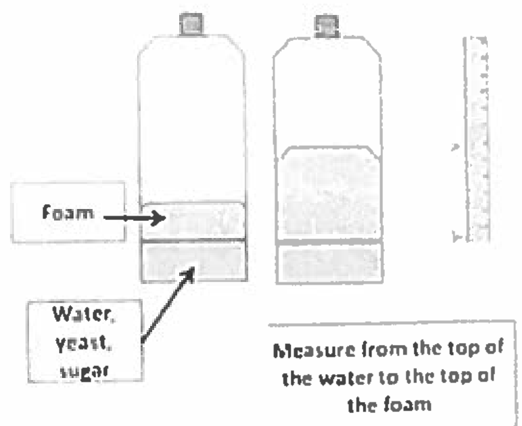
You will test temperature to see its effect on the yeast's rates of respiration. Afterwards, you will analyze data given to you from your partner scientist testing the effect of the amount of sugar on the respiration rates to make your argument for the best conditions for yeast.

Part 1: Guided Experimentation

Focus Question: How does temperature affect yeast respiration?

Prediction: Record your prediction in the notebooks and include your reasoning.

Procedures:



1. Label each of the 3 bottles provided to your group.
   a. Low: 20°C
   b. Medium: 50°C
   c. High: 70°C
2. Measure out 60 ml of each water into the 3 bottles
3. Measure 1 tsp of sugar into each bottle using the funnel.
4. Measure 1 tsp of yeast into each bottle using the funnel.
5. Stir mixture in bottles with straw.
6. Immediately start your timer.
7. Make initial observations and write them down.
8. Every 3 minutes measure the foam that develops on top of the water in centimeters (not the yeast, sugar and water mixture at the bottom).
9. Stop measurements at 12 minutes.

Data Table: - The Effect of Temperature on Yeast Respiration Rate

Time (Minutes)	Height of Foam in Centimeters		
Temperature of water added	LOW 20°C	MEDIUM 50°C	HIGH 70°C
Start 0 min			
3 min			
6 min			
9 min			
12 min			

Data Table Trends:

Describe the data trend for **each bottle with a different temperature** in your notebooks. Try to use words that describe change, like "increase" or "decrease" AND how quickly/slowly each changed. Be sure to use SPECIFIC numbers as evidence.

> *For example, ""The height of the foam in 20°C increased quickly in the beginning, but much slower the last 6 minutes. The foam started at 0.2 cm, then growing to 2 cm at 6 minutes, but only grew to 2.3 cm at 12 minutes."*

Graphing:

a. Set up a graph for the data with "Height of foam in centimeters" on the Y-axis and "Time in minutes" on the X-axis.
b. Graph the data for each bottle with a different temperature on the same graph as a separate line/set of data. Make sure you have a way to distinguish the bottles with different temperatures on the graph.

Bread Recommendations

Problem:

You are a scientist researching the respiration of yeast. Your task is to recommend the best conditions for yeast to perform respiration in order for the biodomians to make bread.

Recommendation for Temperature of Water and Amount of Sugar to Add to Yeast

Using CER language, answer the prompts below. Use complete, thoughtful, detailed sentences.

CER Writing Prompts:

- **Claim:** Looking at the data and graphs, what temperature and *which amount of sugar would you recommend the scientists to give their yeast in order to make the best bread?*
- **Evidence:** What specific evidence from the data can you provide to prove the claim?
- **Reasoning:** Explain why your evidence proves your claim. Explain any scientific ideas that might help you prove your point.

Claim = "What do you know?"	Evidence = "How do you know that?"	Reasoning = "Why does your evidence support that claim?"
Claims are statements that answer your original question.	The evidence is all of the scientific data (or observations) that support your claim.	Reasoning is the explanation that connects your claim to the evidence that supports it.
FINAL CLAIM - *AFTER* research	*SCIENTIFIC* evidence from *RESEARCH*	Explain the scientific reasons

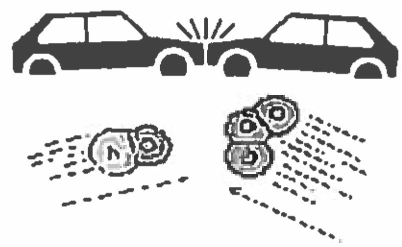
Name ______________________________ Date ____________ Period ________

7.3.1 Resource Sheet: Reading - Changing the Rate of Reaction

Directions: Read the article closely and follow the instructions on your Talking to the Text and Annotating Rubric.

Rate of Reaction

The **rate of a reaction** is the speed at which a chemical reaction happens. If a reaction has a low rate, that means the molecules combine at a slower speed than a reaction with a high rate. Some reactions take hundreds, maybe even thousands, of years while others can happen in less than one second. If you want to think of a very slow reaction, think about how long it takes plants and ancient fish to become fossils (carbonization).



There is another big idea for rates of reaction called **collision theory**. The collision theory says that as more collisions occur in a system (think of molecules hitting each other like cars colliding as seen in the figure on the right), there will be more combinations of molecules bouncing into each other with a higher chance that the molecules will complete the reaction and speed up the reaction. In fact, many of the reactions that happen in living things need to be sped up, in order for the organism to survive.

It's Getting Hot, Hot, Hot

Reactions happen - no matter what. Chemicals are always combining or breaking down. The reactions happen over and over, but not always at the same speed. Sometimes it is necessary to speed up the reaction. When you raise the temperature of a system, the molecules bounce around a lot more and thus, have more moving energy called **kinetic energy**. When they bounce around more, they are more likely to collide. That fact means they are also more likely to combine and have enough energy to change the **reactants** into **products**. See FIGURE 1 for reactant molecules with more kinetic energy.

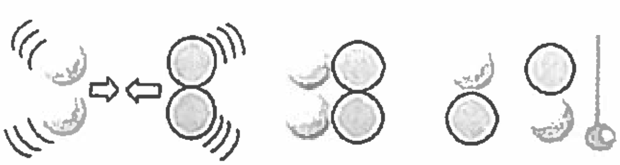


FIGURE 1

For reactant molecules to react, they need to collide with enough kinetic energy to come apart and recombine to make the products. When you lower the temperature, the molecules are slower, collide less, and thus, the reactant molecules just bounce off and do not react. See FIGURE 2 for reactant molecules with less kinetic energy. That

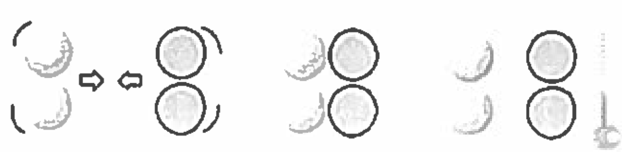
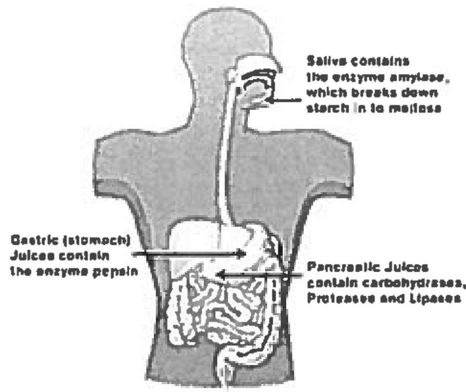


FIGURE 2

temperature drop lowers the rate of the reaction.

The Special Case of the Enzyme

When a cell needs to get something done, it almost always uses a special chemical called an **enzyme** to speed things along. Humans and yeast are very different, but both organisms have certain enzymes to speed up their reactions. For example, in the digestive system, enzymes break down large carbon-containing nutrients (e.g. starch, proteins and fats) into small molecules that can be absorbed into the blood and eventually get to the cell that needs it as seen in the figure to the right.



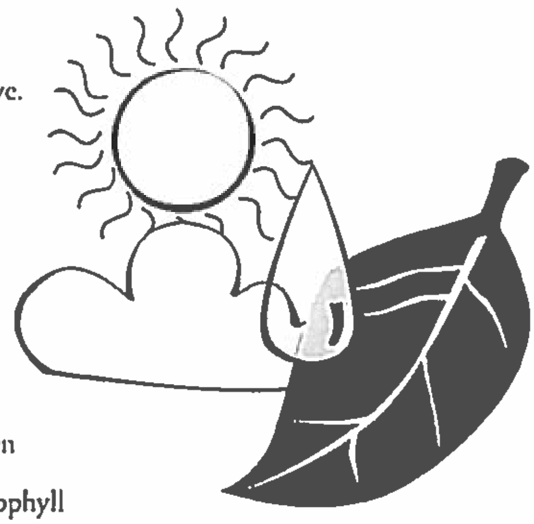
How Enzymes Work

Enzymes are very specific. This means that each type of enzyme only reacts with the specific type of substance that it was made for. The environment of the enzyme can also affect how the enzyme works or even stop it from working. Here are two **factors** that can affect enzymes:

- **Temperature** - Increasing the temperature increases the kinetic energy of the enzyme and reactant molecules so that they move faster and are more likely to collide, thus increasing the rate of the reaction. However, at some point the temperature will become so high that the enzyme will denature and stop working.
- **Concentration** - A higher concentration (how much of a substance is in the system) of the enzyme or reactant can increase the reaction rate.

Adapted from *Chem4Kids.com*, *.abpischools.org.uk*, *ducksters.com* and *middleschoolchemistry.com*

Is It Food for Plants?



Organisms, including plants, need food to survive. Put an X next to the things you think plants use as food.

___ sunlight
___ plant food from a garden store
___ sugar
___ carbon dioxide
___ minerals
___ fertilizer
___ soil
___ water
___ leaves
___ oxygen
___ chlorophyll
___ vitamins

Explain your thinking. How did you decide if something on the list is food for plants?

Elodea Simulation Data

First Claim:

Data Collection Part 1

Constants: Set simulation to **white light**, **half CO2** level, and **25°C** temperature level.		
Light Intensity	**Number of Bubbles in 30 seconds**	What is being tested (independent variable)?
10		
20		
30		
40		
50		

1. Trend: Based on the data, what trend (pattern) do you see?

2. Does this data make sense to you given what you saw during plant investigations with the Elodea and light intensity based on distance? Explain.

Data Collection Part 2

Constants: Set simulation to **half CO2** level, **25 light intensity** level, and **25°C** temperature level.		
CO2 level	**Number of Bubbles in 30 seconds**	What is being tested (independent variable)?
Orange		
Green		
Blue		
White		

1. Trend: Based on the data, what trend do you see?

Data Collection Part 3

Constants: Set simulation to **white light**, **25 light intensity** level, and **half CO2** level.		
Temperature (°C)	**Number of Bubbles in 30 seconds**	What is being tested (independent variable)?
10		
25		
40		

1. Trend: Based on the data, what trend do you see?

Test to see which variable is most important to plants being able to produce oxygen

Trial #	Temperature (°C)	Color of Light	Light Intensity	Number of O_2 bubbles produced in one minute
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

Final Argument and Discussion

Guiding Question: Which variable (light intensity, color of light, or water temperature) is most important to plants being able to produce oxygen?

PAIR SHARE OUTS

Look back at your first claim. Based on the data from your online lab simulation, which variable (light intensity, color of light, or water temperature) is most important to plants being able to produce oxygen? Be sure to include Claim, Evidence, and Reasoning. It is ok if your claim changes from the first claim, just make sure your claim is supported by your evidence.

Use this format for your poster and be prepared to share:

Evidence	
Claim	Reasoning

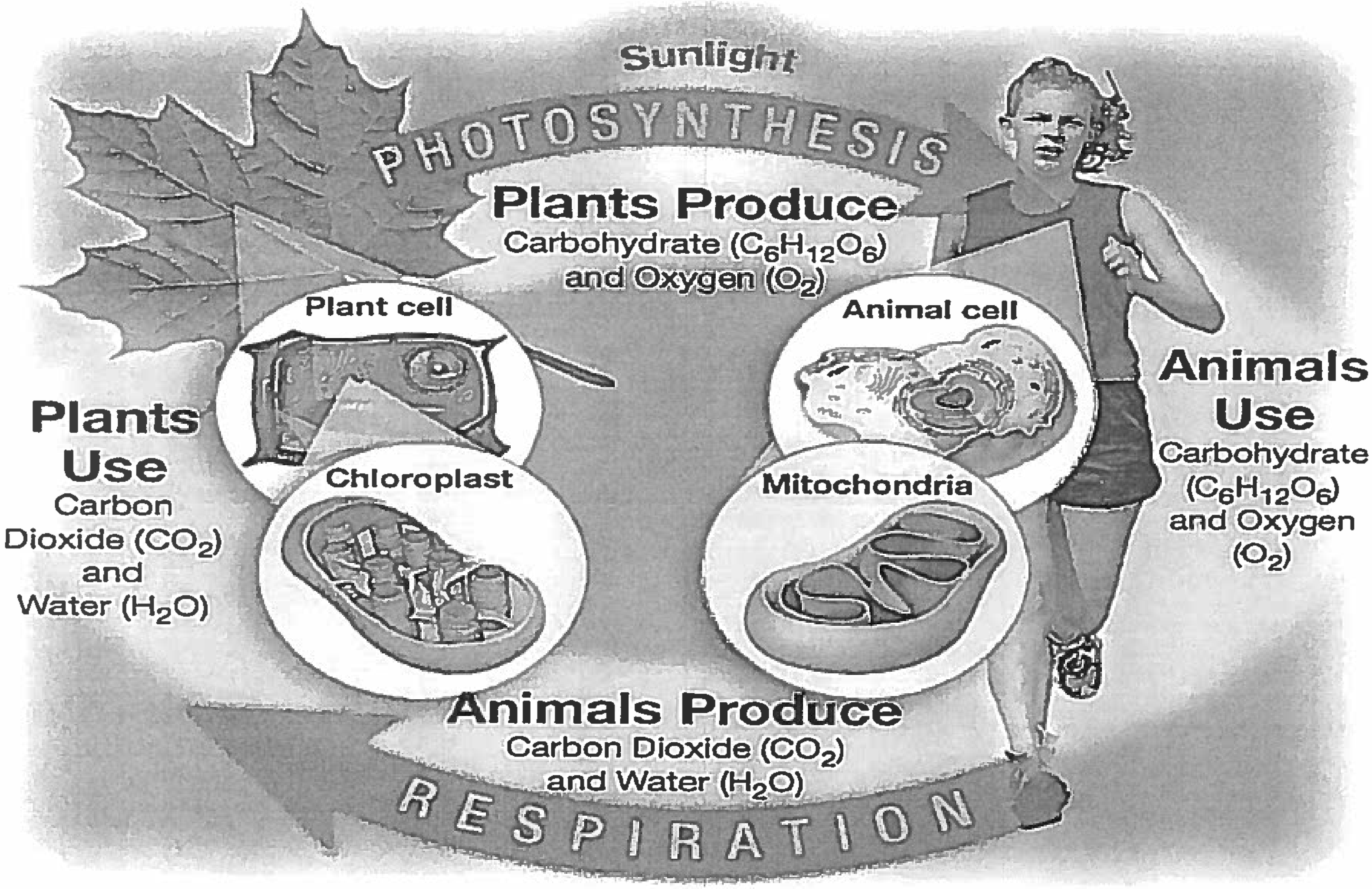
INDIVIDUAL WRITING → (Left side of notebook)

Final Claim

1. Write a claim that answers which variable (light intensity, color of light, or water temperature) is most important to plants being able to produce oxygen? Be sure to include Claim, Evidence, and Reasoning. It is ok if your claim changed, just make sure your claim is supported by your evidence.

Opposite Processes - Annotations

Focus Question: How do the chemical reactions of photosynthesis and respiration support life on Earth?

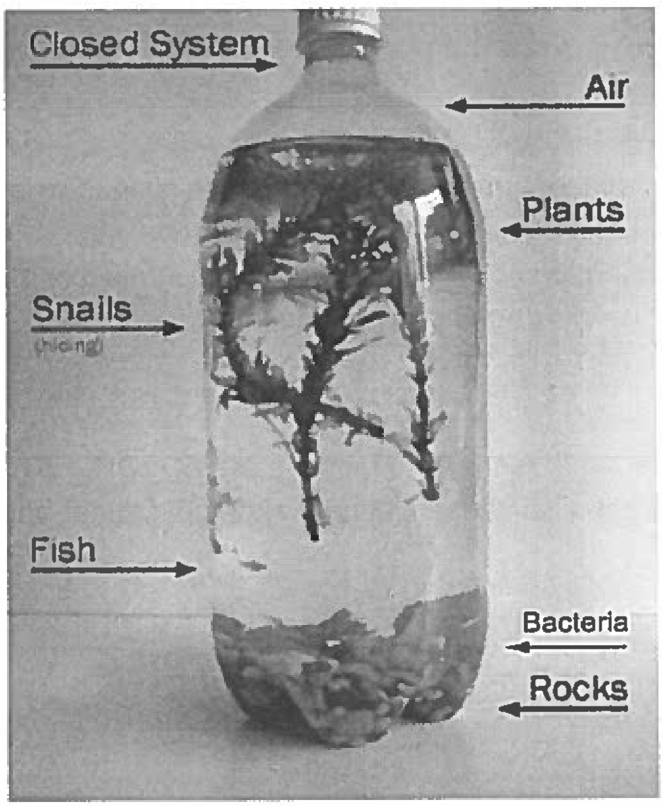


Task:

- Develop a model to explain how photosynthesis and respiration make survival possible in the closed system of an ecobottle.
- Use the model to explain how the chemical reactions of photosynthesis and respiration support life on earth.

Task Steps:

1. **INDIVIDUAL MODELING:** Create a model on a sheet of paper that explains how photosynthesis and respiration are essential to survival in the ecobottle below.



Note: The liquid is freshwater and the snails and fish both feed on the plants in the bottle.

2. Make sure your model:
   - ❑ Labels organisms in the system
   - ❑ Identifies clearly the chemical substances (matter) that flow within the system
   - ❑ Has a system for identifying matter flow AND energy flow
   - ❑ Identifies the changes of different forms of matter or energy
   - ❑ Shows interactions between the living and nonliving components of the ecobottle
   - ❑ Connects photosynthesis to the survival of living components in the system
   - ❑ Connects respiration to the survival of living components in the system

ECOBOTTLE READING

Thriving since 1960, my garden in a bottle: Seedling sealed in its own ecosystem and watered just once in 53 years

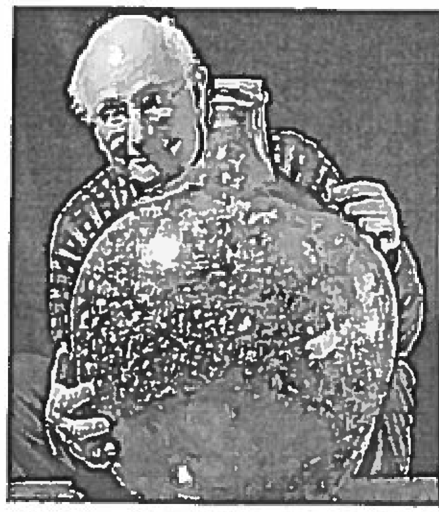
BACKGROUND:

- David Latimer first planted his bottle garden in 1960 and last watered it in 1972 before tightly sealing it shut 'as an experiment'
- The hardy spiderworts plant inside has grown to fill the 10-gallon container by surviving entirely on recycled air, nutrients and water
- Gardeners' Question Time expert says it is 'a great example just how pioneering plants can be'

To look at this flourishing mass of plant life you'd think David Latimer was a green-fingered genius. Truth be told, however, his bottle garden – now almost in its 53rd year – hasn't taken up much of his time. In fact, on the last occasion he watered it, Ted Heath was Prime Minister and Richard Nixon (the 37th president) was in the White House.

For the last 40 years the bottle has been completely sealed from the outside world. But the indoor variety of spiderworts (or Tradescantia, to give the plant species its scientific name) within the bottle has thrived, filling its globular bottle home with healthy vegetation.

Yesterday Mr Latimer, 80, said: 'It's 6ft from a window so gets a bit of sunlight. It grows towards the light so it gets turned round every so often so it grows evenly. Otherwise, it's the definition of low-maintenance. I've never trimmed it, it just seems to have grown to the limits of the bottle.'

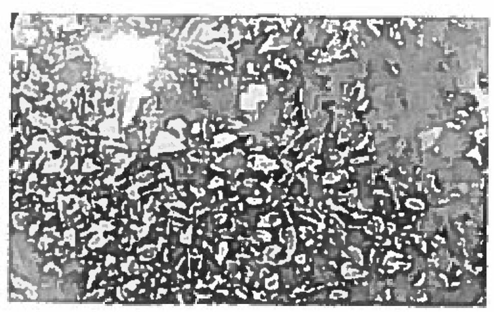


Still going strong: Pensioner David Latimer from Cranleigh, Surrey, with his bottle garden that was first planted 53 years ago and has not been watered since 1972 - yet continues to thrive in its sealed environment

The bottle garden has created its own miniature ecosystem. Despite being cut off from the outside world, because it is still absorbing light it can photosynthesize, the process by which plants convert sunlight into the energy they need to grow.

HOW THE BOTTLE GARDEN GROWS

Bottle gardens work because their sealed space creates an entirely self-sufficient ecosystem in which plants can survive by using photosynthesis to recycle nutrients.



Lush: Just like any other plant, Mr Latimers's bottled specimen has survived and thrived using the cycle of photosynthesis despite being cut off from the outside world

The only external input needed to keep the plant going is light, since this provides it with the energy it needs to create its own food (sugar) and continue to grow.

Light shining on the leaves of the plant is absorbed by proteins containing chlorophyll, a green pigment. Some of that light energy is stored in the form of adenosine triphosphate (ATP), a molecule that stores energy. This creates a chemical reactions that convert carbon dioxide into carbohydrates (sugar), releasing oxygen.

This photosynthesis process is the opposite of the cellular respiration that occurs in other organisms, including humans, where carbohydrates (sugar) react with oxygen to produce carbon dioxide, water, and release chemical energy.

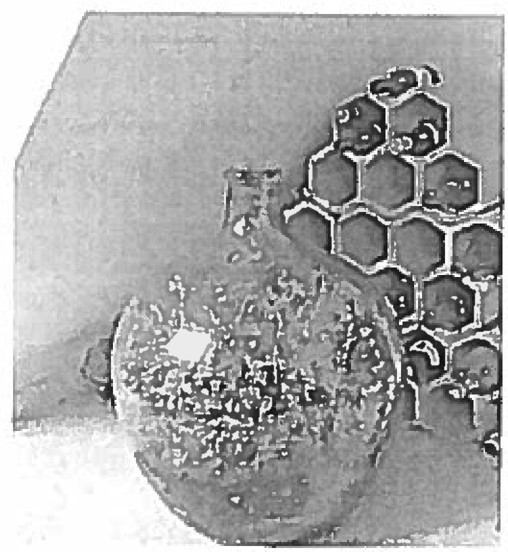
But the ecosystem inside the bottle also uses cellular respiration to break down decaying material shed by the plant. In this part of the process, bacteria inside the soil of the bottle garden absorb the plant's waste oxygen and release carbon dioxide, which the growing plant can reuse during cellular respiration. And, at night, when there is no sunlight to cause photosynthesis to occur, the plant will also use cellular respiration to keep itself alive by breaking down the stored nutrients.

Because the bottle garden is a closed environment, that means its water cycle is also a self-contained process. The water in the bottle gets taken up by plants' roots, is released into the air during transpiration, condenses down into the potting mixture, where the cycle begins again.

Photosynthesis creates oxygen and also puts more moisture in the air. The moisture builds up inside the bottle and 'rains' back down on the plant.

The leaves the plant sheds rot at the bottom of the bottle, creating the carbon dioxide also needed for photosynthesis and nutrients, which it absorbs through its roots.

Real World Connection



Garden designer and television presenter Chris Beardshaw said: 'It's a great example of the way in which a plant is able to recycle... It's the perfect cycle of life.'

He added that this process is one reason why NASA was interested in taking plants into space.

'Plants operate as very good scrubbers, taking out pollutants in the air, so that a space station can effectively become self-sustaining,' he said. 'This is a great example of just how pioneering plants are and how they will persist given the opportunity.

'The only input to this whole process has been solar energy, that's the thing it has needed to keep it going. Everything else, every other thing in there has been recycled. That's fantastic.'

Ecobottle Reading Questions

1. Who is David Latimer?

2. How many times had the plant in the ecobottle been watered?

3. Why does Mr Latimer spin the ecobottle?

4. What happens to the dead leaves that fall off the plant?

5. Describe what occurs during the process of photosynthesis.

6. Describe what occurs during the process of cellular respiration.

7. Explain how the organisms (plant and bacteria) inside the sealed bottle have been able to stay alive since 1960.

Name: ______________________________ Period: ____ Date: __________

7.3.3 Stronger and Clearer Each Time - Output Sheet

Connecting Photosynthesis and Respiration

Directions: Use your revised ecobottle model to do the following:

1. On the back of this paper, explain how carbon cycles in different forms between the living and nonliving components within the ecobottle?
2. In the space below under ME, write 2-3 key words you used in your paragraph on the back.
3. After each conversation with a partner, build from and borrow your partner's ideas and language to make your answer *stronger AND clearer each time* with better and better evidence, examples, and explanations by writing 2-3 key words/phrases below. You will have three conversations.

Name	Thoughts on the concept
Me (Orginal):	
1st person I spoke to:	
2nd person I spoke to:	
3rd person I spoke to:	

Self-Assessment:

Look at your ecobottle model. Keeping in mind how you used your model to explain how carbon cycles and what you heard from the conversations, how could you make your model stronger and clearer?

Adapted from Zwiers "Stronger and Clearer Each Time"

Task:

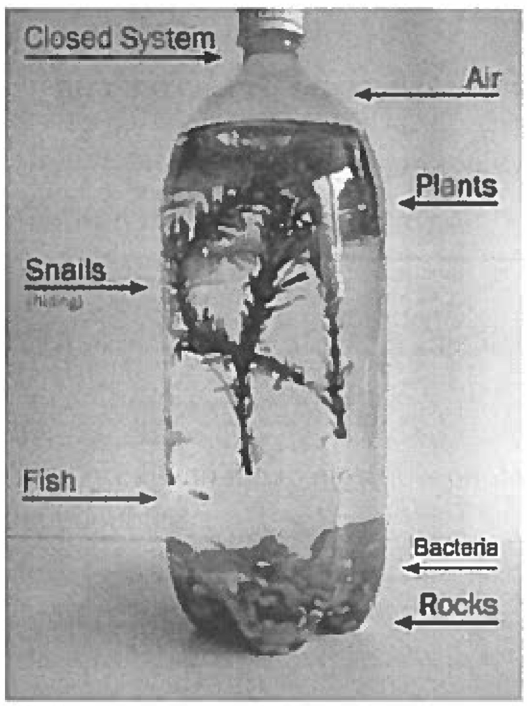
- Develop a model to <u>explain</u> how photosynthesis and respiration make survival possible in the closed system of an ecobottle
- Use the model to <u>explain</u> how the chemical reactions of photosynthesis and respiration support life on earth

-

Task Steps:

1. Use the checklist rubric to make sure your model is complete.

2. **INDIVIDUAL MODELING:**
   On the back, create a FINAL model that <u>explains</u> how photosynthesis and respiration are essential to survival in the ecobottle



Note: The liquid is freshwater and the snails and fish both feed on the plants in the bottle.

3. **INDIVIDUAL EXPLANATION:**
   Below your drawing, answer the following questions about your model:
   a. How do the chemical reactions of photosynthesis and respiration support human survival on Earth? Be detailed.
   b. Predict/Explain what would happen to the ability of organisms in the ecobottle to perform photosynthesis and respiration if foil was wrapped around the bottle such that light could not enter.

Name: ______________________________ Period: ____ Date: ______ **Page: 212**

7.3.S Resource Sheet: Introduction to Biodome Catastrophe

1. Task Context

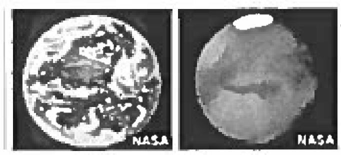
Mars One, a Dutch company, has announced plans to send astronauts on a one-way trip to Mars by 2025 (February 2015,http://www.mars-one.com/). The settlers will live out their lives on the surface of Mars for the rest of their lives.

Figure 1. Mars One colony settlements will look similar to the image above.

Figure 2. Biodome will be blocked off from the surrounding ecosystem. Only sunlight will be able to enter through.

In order to prepare and learn about some of the challenges that the astronauts may face, an independent laboratory company in the United States has sponsored a project called "Biodome." By 2017, they plan to send a team of eight scientists and two doctors into the Biodome to work together, grow their own food, and see if they could survive in a closed ecosystem on Earth for at least 2 years.

The goal behind the project is to gather information prior to sending a colony up to Mars where the atmosphere is quite different *(refer to figure 3)*. Biodome provides an opportunity to learn in a closed environment and conduct experiments on how to manage resources while also having to address relevant risks that may arise on Mars. In this closed system, as much of the matter as possible will be cycled, including water, waste, nutrients, etc. However, energy will be transferred in and out as needed.



	Earth	Mars
Carbon Dioxide (CO_2)	0.03%	95%
Nitrogen (N_2)	78%	2.7%
Oxygen (O_2)	21%	0.13%
Argon (Ar)	0.9%	1.6%
Methane (CH_4)	0.002%	0

Figure 3. *Taken from ucar.edu*

In the Biodome, there will be bedrooms, working areas, a living room and a 'plant production' area, where they will grow various vegetables and greens. The scientists and doctors will be able to prepare fresh food (that they themselves grew and harvested) in the kitchen, and try to lead typical day-to-day lives. They will be keeping a journal during their trip to record their experience and any changes they may experience in the Biodome on a daily basis.

2. Task Explanation

The scientists and doctors, together known as Biodomians, plan to keep in close contact with Biodome Headquarters. You have been hired as an environmental scientist to communicate with the Biodomians on a regular basis. You will be working with the team at Biodome Headquarters to analyze data and ensure that the doctors and scientists are safe. This project also depends on maintaining the closed system as much as possible, thus the dome can only be opened in an emergency.

Name: ______________________________ Period: ____ Date: ______

7.3.S Resource Sheet: Journal Entries

Biodome Journal Entries

Week 1 - Entry from a Biodomian's notebook : Everything seems to be functioning properly here in the Biodome. We started to plant our own crops such as hyacinth beans and sweet potatoes. I have measured the Hyacinth Beans to be 1.8m high. I am very excited to see how they continue to grow.

Week 5- Entry from a Biodomian's notebook: I am starting to really get sick of all the sweet potatoes we are eating here. The hyacinth beans seem to be having trouble adjusting to the environment here as they are now 1.5m tall and some of the leaves are beginning to turn brown. I am noticing that the scientists are complaining that it seems like it is getting harder to breathe and stay entertained.

Week 10 - Entry from a Biodomian's notebook: We are getting really worried about the crops here because the hyacinth beans have wilted and are now only 1.2m tall. We also found dead insects and worms in the soil. Our doctors have reported that everyone has complained about low energy levels.

Week 15 - Entry from a Biodomian's notebook: I am starting to feel extremely exhausted. I woke up in the middle of the night feeling like I could not breathe. Hopefully the doctor can figure out what is happening. I went to check on the crops earlier this week and only half of the hyacinth beans are still alive and only 1m tall. The birds in the Biodome haven't been making much noise recently.

Name: ______________________________ Period: ____ Date: ___________

7.3.S Resource Sheet: Data

Biodome Environmental Data - Review the data that the Biodomians have been collecting. All the data is an average of the data taken during the week from the Biodome's plant growth area. Analyze the data and follow the directions to save the plants and scientists.

Table 1: Weekly Average Environmental data recorded at 12:00 p.m. (noon)

Week	Temp (°C)	Light Intensity (%)	CO_2 (% of air)	Water (H_2O) taken up by roots	O_2 (% of air)[1]	Photosynthesis Rate (O_2 production)
1	25	100	0.030	1.0	21	100
2	24	100	0.030	1.0	20	100
3	25	100	0.028	1.0	19.5	90
4	25	98	0.28	1.0	19	85
5	24	100	0.026	0.9	19	80
6	25	100	0.025	0.9	18.5	80
7	25	100	0.022	0.8	18	70
8	24	99	0.021	0.7	19.0	70
9	23	99	0.020	0.7	18.5	70
10	24	100	0.018	0.7	17	60
11	24	98	0.019	0.5	18	65
12	24	100	0.017	0.4	17	50
13	25	99	0.015	0.4	16.5	45
14	24	100	0.015	0.3	16.5	40
15	24	100	0.014	0.3	16.5	30
16	24	100	0.014	0.3	16.0	25
17	24	100	0.013	0.3	16.0	25
18	25	100	0.013	0.3	15.5	25
19	24	100	0.013	0.3	15.5	25
20	25	100	0.013	0.2	15.5	20

[1] For humans and many animals to sustain normal functions, the Occupational Safety and Health Administration, OSHA, determined the optimal breathing range to be between 19.5 and 23.5 percent oxygen. Serious side effects will occur if the oxygen levels are outside of the safe zone. At levels at or below 17 percent, your mental abilities become impaired. Levels under 14 percent will cause extreme exhaustion from physical activity.

Task Problem

Mars One, a Dutch company, has announced plans to send astronauts on a one-way trip to Mars by 2025 (February 2015,http://www.mars-one.com/). The settlers will live out their lives on the surface of Mars for the rest of their lives. To test the living conditions, a Biodome has been built to house scientists and doctors in a sealed environment. The two year experiment will determine if it is feasible to use a dome structure on Mars for living quarters and growing food.

The scientists and doctors, together known as Biodomians, plan to keep in close contact with Biodome Headquarters. You have been hired as an environmental scientist to communicate with the Biodomians on a regular basis. You will be working with the team at Biodome Headquarters to analyze data and ensure that the doctors and scientists are safe. This project also depends on maintaining the closed system as much as possible, thus the dome can only be opened in an emergency.

This Biodome project improved the design of the glass structure to allow more sunlight to come in. However, you just received the latest report from the doctors that they are concerned that the Biodomians are complaining about having very little energy and seem very unhappy. The scientists have reported that the plants and crops in the Biodome's ecosystem are starting to die.

Your task is to figure out:

(1) What is the *main issue* facing the Biodomians? You will present evidence of that problem to the management of the Biodome project.

(2) What would you investigate to determine the cause and solution of the *main issue* you identified above?

1. **With your team, analyze the data from the biodome.**
   A. For each of the columns in Table 1, write a sentence to describe the trend of the data for each factor below.
      - Temperature:
      - Light Intensity:
      - CO_2 level:
      - O2 level:
      - Water taken up by roots:
      - Photosynthesis rate

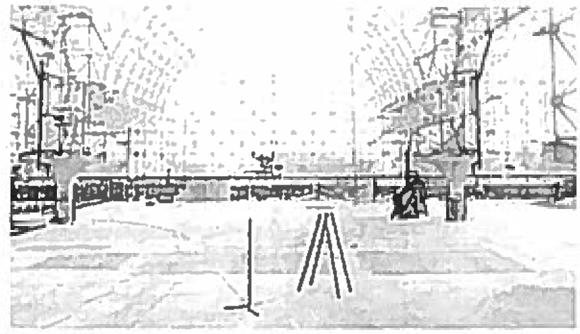
   B. Create graphs of the most important data
      a. Graph the photosynthetic rate over time
      b. Graph the factor you believe is causing the problem (*Temperature, Light Intensity, CO_2 level, O_2 level, Water taken up by roots*) over time
      c. Include titles, labels, and keys.
      d. Describe relationships observed in the data once graphed.
         i. the story of the two sets of data and how they are connected.
         ii. the importance of any relevant breakpoints in the data.

C. Discuss and list conclusions describing how the data relates to your knowledge of photosynthesis and explains the issues of plant growth in the biodome.

2. **Individual after reading the explanation about the concrete. Explain the Problem** (C-E-R-R)
   After examining the data, make a clear claim as to which factor is causing the plants to die and the Biodomians' loss of energy. Be sure to support this with evidence from the reading and data resources provided. Make sure to include each of the following in your explanation:
   - **reasoning that includes the role of photosynthesis in this problem**
   - **reasoning that includes the role of cellular respiration in this problem**
   - **an argument against another factor being the cause of the problem**

Life Under the Bubble

Biosphere 2 was one of the most lauded experiments of the 1990s, then one of the most ridiculed. Now it is back, offering a unique way to put theories about climate and environment to the test.



By Jordan Fisher Smith|Monday December 20, 2010

Constructed between 1987 and 1991, Biosphere 2 was a 3.14-acre sealed greenhouse containing a miniature rain forest, a desert, a little ocean, a mangrove swamp, a savanna, and a small farm. Its name gave homage to "Biosphere 1"—Earth—and signaled the project's audacious ambition: to copy our planet's life systems in a prototype for a future colony on Mars. A May 1987 article in DISCOVER called it "the most exciting scientific project to be undertaken in the U.S. since President Kennedy launched us toward the moon." In 1991 a crew of eight sealed themselves inside. Over the next two years they grew 80 percent of their food, something NASA has never attempted. They recycled their sewage and effluent, drinking the same water countless times, totally purified by their plants, soil, atmosphere, and machines. It wasn't until 18 years later, in 2009, that NASA announced total water recycling on the International Space Station. At the end of their stay, the Biospherians emerged thinner, but by a number of measures healthier.

Despite these successes, the media and the science establishment seized upon the ways in which the project had failed. Chief among these was an inability of Biosphere 2's atmosphere to sustain human life. As was true outside, the problem was signaled by rising carbon dioxide. By 1996 Biosphere 2 had passed into the hands of Columbia University, and later the University of Arizona took over. Both used it to run scenarios of global climate and atmospheric change. In its later life, "instead of trying to model utopia, Biosphere 2 would actually model *dystopia*—a future plagued by high carbon dioxide levels," wrote Rebecca Reider, author of a definitive history of the project. But while most research on impending environmental disaster relied on computer models, Biosphere 2 represented a fascinating alternative mode in which large-scale analog experiments employed real organisms, soil, seawater, and air.

In September 1991, four women and four men in NASA-style jumpsuits entered the air lock of Biosphere 2. Soon after, signs of trouble with the internal atmosphere began within 24 hours. Each morning the crew had a breakfast meeting over bowls of home-grown porridge in *Star Trek*–style chairs around a polished black granite table. The morning after closure, the crew captain announced that carbon dioxide in Biosphere 2's atmosphere had risen to 521 parts per million, a 45 percent increase above levels outside at the time. By the following day, the lowest it went was 826. Over the months that followed, the news at the morning meetings got worse. Crew members were feeling tired and began to pant when they climbed stairs. Scientists soon discovered that the culprits in the carbon dioxide problem were the tiniest organisms on board: soil bacteria.

The process of their subversion was respiration, in which living things release carbon dioxide into the atmosphere. Green plants absorb sunlight and carbon dioxide during photosynthesis, making carbohydrates and releasing oxygen, but they also do the reverse: Plants, too, respire (or breathe), burning carbohydrates to do work like making branches and roots. In the soil around their roots, billions of fungi and soil bacteria respire as well. In fact, the greater part of all "breathing" in terrestrial systems goes on underground.

Ever grand in their ambitions, Allen and his people intended Biosphere 2 to be used by rotating crews for 100 years. Feeling they had one shot to invest their world with life-giving nutrients, they had loaded their soils with compost and rich muck from the bottom of a cattle pond. When the air locks closed, soil bacteria had a massive party, exhaling carbon dioxide and tipping the balance the wrong way.

As oxygen was converted to carbon dioxide, free oxygen in the atmosphere declined. By January 1993, Biosphere 2's carbon dioxide levels were 12 times that of the outside, and oxygen levels were what mountaineers get at 17,000 feet. The crew's doctor was having trouble adding up simple figures and disqualified himself from duty. So, a year and four months into the mission, tank trucks containing 31,000 pounds of liquid oxygen started driving up the access road to the site.

Biosphere II Model

After reading the article "*Life Under the Bubble*", please draw and label 5 things that the scientists needed to stay alive in Biosphere II. Refer to page 5 and page 6 of your science notebook for inspiration (Your "Introduction to Life" Cornell Notes).