

The MCA
Foundation
Presents:

STEM Innovation Lab

WORKBOOK



STEM Experiments and Life Sciences
Workforce Data for Middle School
Students and Teachers in El Paso, TX



STEM Innovation Lab
WORKBOOK

Acknowledgments / Disclaimer

Acknowledgments: Thank you to all the teachers who are working tirelessly during these unprecedented COVID-19 times. We would also like to thank our sponsors for giving us the ability to create and fund the STEM Innovation Lab Camp and this workbook.

Legal disclaimer: Please be safe when doing all experiments in this workbook. Most experiments do not use chemicals, heat or any other dangerous substance. Please beware of the safety precautions on some experiments. We do ask that teachers and parents keep an on their students and children when completing the experiments. The MCA Foundation is not liable for any injuries.



ABOUT THE MCA AND AN INTRODUCTION TO PROGRAMS

About the MCA

The Medical Center of the Americas Foundation (MCA) is a non-profit organization whose mission is to foster the growth of the life sciences ecosystem in the Paso del Norte Region.



MEDICAL CENTER
OF THE AMERICAS
FOUNDATION

The initial efforts to diversify our economy into the life-sciences industry starting in 1999 were in bringing a four-year medical school, investing in our hospitals and building a biomedical business incubator, have yielded results that have been nothing short of staggering for a community that was on a 50-year decline... Today, healthcare is the largest private industry in El Paso with an overall city unemployment rate below the state of Texas' and the United States', which also includes the biomedical industry – testing, product development and manufacturing. The MCA has become a complex organization with various programs that reach different populations in our region. In the next couple of pages, you will learn all about our facility and the many components that make up the MCA.

Cardwell Collaborative

The MCA is headquartered inside the Cardwell Collaborative (CC). The \$24 million facility is located in central El Paso, and is certified as a LEED SILVER building, making us a highly energy efficient building. The Cardwell Collaborative is composed of three floors:

- >> The **first floor** is the administrative home of the MCA staff as well as where our conference rooms are located.
- >> Our **second floor** is completely leased by Texas Tech University Health Sciences Center in El Paso. They have various departments working out of the CC.
- >> The **third floor** is where all the magic happens; half of the floor is taken up by UTHealth School of Public Health El Paso Campus, Microsoft, and other Biotechnology and Life Science Startups. The other half is composed of wet and dry labs for innovators' and other start-up's use.

Innovation Center

The MCA Innovation Center is a hub for entrepreneurs and innovators, connecting them to resources, training, and networks to launch and grow their businesses. Local startups have the opportunity to work with the MCA and be able to use resources to help them grow, including use of office and lab space at the Cardwell Collaborative, mentoring support, boot camps and an opportunity to pitch to local investors. Every year the MCA hosts one of our biggest events of the year, Demo Day! It is a day where investors and innovators are put in the same room; the innovators get their opportunity to pitch their startups to try to raise local funding and the investors give feed back to the innovators. At the end of the night, the MCA awards funding to the companies with the best 3 pitches.



Healthcare Programs

The MCA has expanded its efforts in the region to foster a more integrated, high-value, and robust healthcare system in the region. The MCA's Healthcare Program began by organizing a series of exploratory round table meetings with regional healthcare leaders to discuss industry-wide issues, obstacles, barriers, and opportunities. Efforts are now underway to plan and implement a comprehensive and collaborative Military Medical Transition Program (MMTP), incorporating stakeholders from Fort Bliss, regional academic institutions and healthcare organizations. The MMTP supports regional efforts to grow the talent pool in critical healthcare occupations, as well as improving the integration of Soldiers and families assigned at Fort Bliss into the El Paso civilian community.

BIO-El Paso Juárez (Bio-EPJ)

BIO El Paso-Juárez convenes industry, government, non-profit & educational institutions to improve the region's biomedical competitiveness. It provides a recognized platform for enhancing the El Paso/Juarez biomedical ecosystem and accelerating the formation, expansion/retention and attraction of biomedical enterprise in the region – with an initial focus on medical device manufacturing. The medical device industry in the Paso del Norte region is much bigger than people think. We have more than 40 companies that manufacture and supply medical devices in the region and nationally with over 40,000 employees.

Medical devices can be classified into three levels:

- >> **Class 1:** Devices that generally pose the lowest risk to the patient and/or user (e.g. tongue depressor, stethoscope)
- >> **Class 2:** Devices that pose mid to high risk to the patient and/or user (e.g. needles, IV lines, catheters)
- >> **Class 3:** Devices that pose the highest risk to the patient and/or user (e.g. X-ray machine, MRI, CT, pacemakers)



Clinical Trials Consortium

The Clinical Trials Consortium's (CTC) objective is to grow clinical trial activity and infrastructure in our region by expanding the number of trials, investigator sites, principal investigators, and clinical research coordinators. Clinical trials are tests and research performed on human subjects to validate the effectiveness of a new invention, medication or treatment. Clinical trials are vital to the healthcare industry; they are how new medications, vaccines, medical devices and other innovative ideas are rigorously tested so they can be safely administered to patients. During the time of COVID-19, clinical trials were extremely important to create and administer the most effective vaccine to the global population to reduce the spread of the disease.

Workforce - Investing in Our Future

Demand for a skilled workforce in science, technology, engineering and math (STEM) is linked to global competitiveness and economic opportunity. The MCA's Workforce Initiative aims to increase awareness of the emerging healthcare and high-tech biomedical industry in the region. We do so by participating in community outreach events, hosting STEM camps, giving tours of the CC and open houses for the community, as well as running an internship program. It is vital for us to create an environment that is able to expose our students to the vast selection of jobs in the life sciences industry. It is no longer just about working in a hospital, the life sciences industry consists of research labs, startups, clinical trials, medical device manufacturers, and public health departments that make up our biomedical ecosystem in our region. We have made our mission to create awareness among our youth that there is no need to leave El Paso to get a great education and have a fulfilling job while contributing to the region's economic prosperity.

ABOUT THE WORKBOOK

In response to adapting to the now socially distanced and remote life that was forced on us by the COVID-19 pandemic, the MCA created this STEM workbook to provide students with the same resources that we used to provide at the Cardwell Collaborative (CC) at home. As of 2019, the MCA was hosting full day STEM camps at the CC in partnership with Workforce Solutions Borderplex to create a day filled with various activities that would teach students about the life sciences industry in the region. We would discuss innovation, entrepreneurship, clinical trials and medical devices while mentioning all the different career possibilities. When the pandemic closed our and all schools' doors, we had to switch gears and find another way of sharing this information. After weeks of research, we decided to speak to teachers to get a better idea of what we could do to help. We interviewed various teachers from different districts including EPISD, SISD, YISD, private charter schools and a homeschool group. After much consideration we decided that creating a STEM Innovation Lab workbook would be the best fit for teachers and students.

The Workbook was created as a fun resource for students while homeschooling or remote learning with learning objectives for every experiment. This book contains a variety of experiments that use typical household items and products. The experiments were intentionally selected to represent a wide range of STEM concepts that reflect multiple subjects and varying levels of difficulty. You will find that each experiment comes with a detailed methodology and includes regional workforce statistics that link with the science and activities. Accompanying each experiment is an explanation as to why the experiment worked as it did in order to provide a deeper understanding behind each result. Explaining these



concepts not only provides the necessary understanding, but also begins to shape students' minds into thinking about the reasons behind the phenomena they observe in their everyday lives. We hope to engage with students' innate curiosities and provide them with learning they can bring to their classrooms to spark further conversation about the concepts they learn.

From a functional perspective, this workbook is appropriate for all ages. The experiments, however, range in difficulty level. The book is categorized by level of involvement based on the materials list and estimated time to complete each experiment. Each experiment is categorized by concepts and labeled by each general subject illustrated. The goal is to introduce the participant to the subject matter initially and then gradually create a more engaging experience with greater inputs required as the user progresses through the subjects. All the salaries discussed on the workbook are average salaries for 2019 in El Paso. The growth percentage is the increase of job openings by 2026 compared to 2016.



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Chemistry



Biology



Engineering



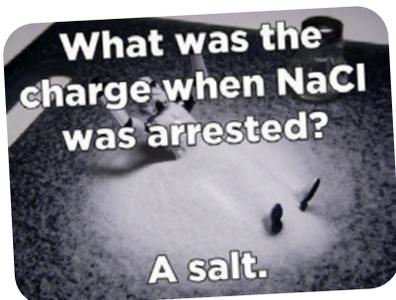
Tech



WHY SO SALTY?

Objective:

- >> This lab will focus on chemistry concepts including:
 - **Desalinization:** The removal of salts and minerals from water
 - **Sodium Chloride (NaCl):** What is salt? Salt is a compound formed by sodium and chloride
 - **Water Cycle:** Briefly introduce the concepts of evaporation, condensation and precipitation



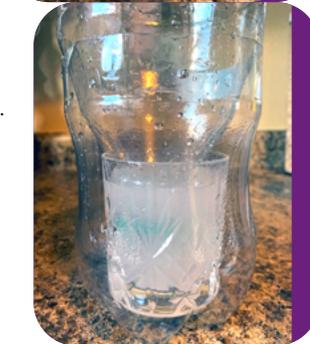
- >> Introduces students to the processes and technologies used to produce desalinated water.
- >> Water desalinization processes separate dissolved salts and other minerals from water.

Materials:

- >> Plastic bottle (Ex. A 2-liter soda bottle)
- >> Small glass or plastic container without a lid that can fit inside the bottle
- >> Salty water
- >> Scissors

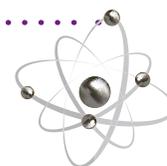
Instructions:

- 1| Half fill a small glass with salty water. Make sure the outside of the glass is clean.
- 2| Cut the PET bottle in half (about 10cm from the bottom).
- 3| Place the small container into the bottom half of the PET bottle.
- 4| Squeeze the top half of the bottle back onto the bottom, so that the top sits just inside the base.
- 5| Leave the bottle out in the sun.
- 6| After an hour or two, check what has happened.



Supporting Science:

- >> The saltwater will be comprised of both salt and water molecules that can be separated through a **phase change**.
- >> When left in the sun, the energy from the heat will cause the water to **evaporate** and change into a gas, water vapor, that can then escape from the container leaving the salt behind.
- >> This water vapor will then eventually **condense** back into liquid on the surface of the larger container and flow back down as pure water into the base of the outside container.



Jobs associated with this Lab:



Environmental Engineer

- >> Discipline that takes from broad scientific topics like chemistry, biology, ecology, geology, hydraulics, hydrology, microbiology, and mathematics to create solutions that will protect and also improve the health of living organisms and improve the quality of the environment.
- >> **Education:** Bachelor's degree in Engineering concentrating in environment, chemical, and civil concepts
- >> **Salary:** \$86,510 / **Growth:** 10.1%

Civil Engineer

- >> Discipline that deals with the design, construction, and maintenance of the physical and naturally built environment, including public works such as roads, bridges, canals, dams, airports, sewerage systems, pipelines, structural components of buildings, and railways.
- >> **Education:** Bachelor's degree in Civil Engineering
- >> **Salary:** \$72,120 / **Growth:** 18.5%

Chemist

- >> Uses the concepts of chemistry to research and develop scientific innovations usually in the medical field, oil and refining field, cosmetics industry and many other.
- >> **Education:** Bachelor's degree in Chemistry
- >> **Salary:** \$83,000 / **Growth:** 9.9%

Chemical Engineer

- >> Uses principles of chemistry, physics, mathematics, and economics to efficiently use, produce, transform, and transport chemicals, materials, and energy.
- >> **Education:** Bachelor's or Master's degree in Chemical Engineering
- >> **Salary:** \$97,970 / **Growth:** 13.0%

Professor/ Post-Secondary Teacher

- >> Academic rank at universities and other post-secondary education and research institutions.
- >> **Education:** Graduate degree or PhD in the specific field
- >> **Salary:** \$48,490 / **Growth:** 15.3%

Operations Researcher Analyst

- >> Carries out academic or scientific research. The subject can vary throughout the region or school, most research is on medical concepts- cancer, Alzheimer's, Parkinson's, genetic mutations. There is also research on seismic activity, water desalinization, global warming, and pharmaceuticals.
- >> **Education:** Graduate or Professional degree in the science field
- >> **Salary:** \$72,110 / **Growth:** 37.1%

Mechanical Engineer

- >> Engineering that focuses on manufacturing and maintaining mechanical systems.
- >> **Education:** Bachelor's and Master's degree in Mechanical Engineering
- >> **Salary:** \$79,400 / **Growth:** 14.5%

Industrial Engineer

- >> Engineering that focuses on the optimization of industrial systems and processes.
- >> **Education:** Bachelor's and Master's degree in Industrial Engineering
- >> **Salary:** \$89,890 / **Growth:** 13.8%

Quiz



- 1| **What is the chemical name of salt?**
 - a. Sodium
 - b. Sodium Chloride
 - c. Potassium
 - d. Chloride

- 2| **What are the physical properties of salt?**

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- 3| **What is water desalinization?**

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- 4| **What is the difference between saltwater and freshwater?**

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- 5| **This experiment deals with the water cycle. What are the four stages of the water cycle?**

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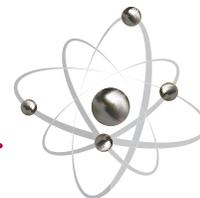
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COLOR MAGIC



Supporting Science:

Objective:

- >> This lab will help the students understand the basics of **Chromatography**.
- >> **Chromatography** can separate inks into the different colors they are made of.
- >> Inks travel in different ways, and some travel faster than others.
- >> **Chromatography** may seem difficult, but it is used in many industries, not only the medical/research field.

Materials:

- >> Pipe cleaner (Chenille Stem)
- >> Coffee filter paper
- >> Different markers of different colors
- >> Cup of water

Instructions:

- 1| Poke a hole through the center of the coffee filter.
- 2| Run one end of the pipe cleaner securely through the hole you just made.
- 3| Using three different markers, draw a circle by dotting different marker colors around the pipe cleaner on the filter paper.
- 4| Place the other end of the pipe cleaner in a cup of water with the coffee filter at the top.
- 5| Observe what happens to the colors with the introduction of water.

- >> **Chromatography** is the separation of a mixture by passing it in solution or suspension or as a vapor (as in gas **chromatography**) through a medium, a substance that conveys something, like water, in which the components move at different rates.
- >> This lab is based on the fact that different types/colors of ink will interact differently with water molecules.
- >> The pipe cleaner will serve as a stem that carries water from the cup and into the filter paper.
- >> Once the water enters the filter paper it will then spread towards the edges and gradually reach the dots you made.
- >> As the water traverses over the dots, the varying color components that make up the overall color of the dot will separate.
- >> Each color will then demonstrate a different level of **attraction** to the water and the colors that are most strongly attracted will be carried the farthest by the water while those colors less strongly attracted will remain closer to the location of the original dot.



Jobs associated with this Lab:



Forensic Analyst

- >> Uses scientific knowledge in order to connect biological markers to important details in a crime.
- >> Education: Bachelor's in Forensic Science or related fields (Biology, Chemistry, etc.)
- >> Salary: \$58,000 / Growth: 17%

Pharmacist

- >> Focus on safely preparing and monitoring medication.
- >> Education: Pharm. D, Pharmacy school
- >> Salary: \$133,450 / Growth: 13.1%

Quiz:



- 1| Colors move at a different rates.
 - a. True
 - b. False
- 2| Why do the colors begin to move?
 - a. Because of their interaction with water
 - b. Because of their interaction with air
 - c. Because of the polar/non-polar interactions
- 3| Would there be a different interaction if instead of using a water medium a more fatty medium was used like milk?

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- 4| Which color moved the quickest based on your results? Why do you think that specific color expanded quicker?

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- 5| What role does the pipe cleaner play in this experiment? Why is this important?

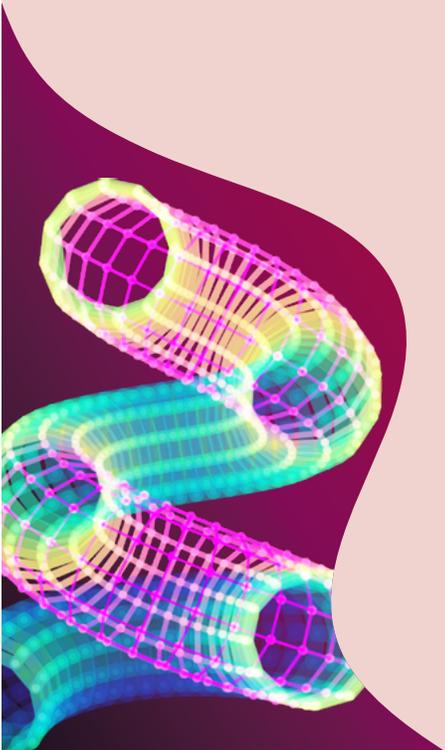
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DRINKING CANDLE

Objective:

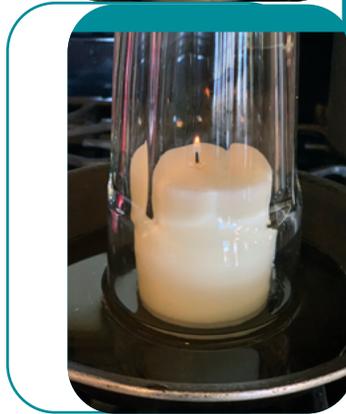
- >> This lab will target topics of **combustion** and **air pressure**.
- >> The objective of this lab is to show how a flame relies on the open air and how water reacts to changes in air pressure.
- >> Students will combine the two concepts to create a **chain reaction**.

Materials:

- >> Cooking pan
- >> 100 ml of water
- >> Candle
- >> Lighter
- >> Glass cup large enough to fully cover the candle
- >> Food coloring

Instructions:

- 1| Pour all 100 ml of water into the pan.
- 2| Add a few drops of food coloring into the water and gently mix the solution.
- 3| Place the candle into the center of the pan so that the bottom portion of the candle is submerged in the water.
- 4| Carefully light the candle.
- 5| Being cautious of the flame, quickly place the glass cup over the candle.
- 6| Let the candle sit for a few moments as it gradually burns out.
- 7| Watch as the water rises into the glass.



Supporting Science:

- >> This experiment uses topics like **air pressure** and **combustion** to show how water can be sucked into the glass.
- >> As the candle burns in the glass, it is using up the oxygen inside.
- >> As the oxygen is removed from the air, the pressure in the glass begins to lower as no more gas molecules are present.
- >> Once the pressure inside the glass drops, the pressure from the air outside the glass pushes its way into the glass and brings the water along with it.
- >> The food coloring helps us track the water as it gets pushed into the glass by the pressure of the outside air.

Jobs associated with this Lab:



Chemical Engineer

- >> Uses principles of chemistry, physics, mathematics, and economics to efficiently use, produce, transform, and transport chemicals, materials, and energy.
- >> Education: Bachelor's or Master's degree in Chemical Engineering
- >> Salary: \$97,970 / Growth: 13.0%

Environmental Engineer

- >> Discipline that takes from broad scientific topics like chemistry, biology, ecology, geology, hydraulics, hydrology, microbiology, and mathematics to create solutions that will protect and also improve the health of living organisms and improve the quality of the environment.
- >> Education: Bachelor's degree in Engineering concentrating in environment, chemical, and civil concepts
- >> Salary: \$86,510 / Growth: 10.1%

Operations Researcher Analyst

- >> Carries out academic or scientific research. The subject can vary throughout the region or school, most research is on medical concepts– cancer, Alzheimer's, Parkinson's, genetic mutations. There is also research on seismic activity, water desalinization, global warming, and pharmaceuticals.
- >> Education: Graduate or Professional degree in the science field
- >> Salary: \$72,110 / Growth: 37.1%

Mechanical Engineer

- >> Engineering that focuses on manufacturing and maintaining mechanical systems.
- >> Education: Bachelor's and Master's degree in Mechanical Engineering
- >> Salary: \$79,400 / Growth: 14.5%

Quiz



1| What caused the water to get sucked up into the glass?

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2| What does the candle need to continue burning?

- a. Oxygen
- b. Carbon Dioxide
- c. Nitrogen
- d. All of the above

3| What takes up more space in the atmosphere, warm air or cool air?

- a. Warm air
- b. Cool air
- c. They are the same
- d. None of the above

4| What do the Gas Laws deal with?

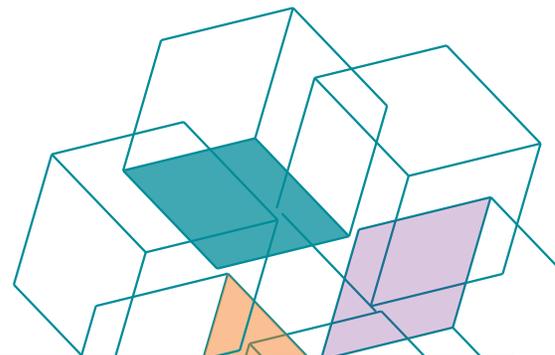
- a. Pressure of gas
- b. Pressure & volume of gas
- c. Pressure, volume, temperature of gas
- d. None of the above

5| BONUS: What are the three Primary Gas Laws?

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GRAPHITE CIRCUIT

Objective:

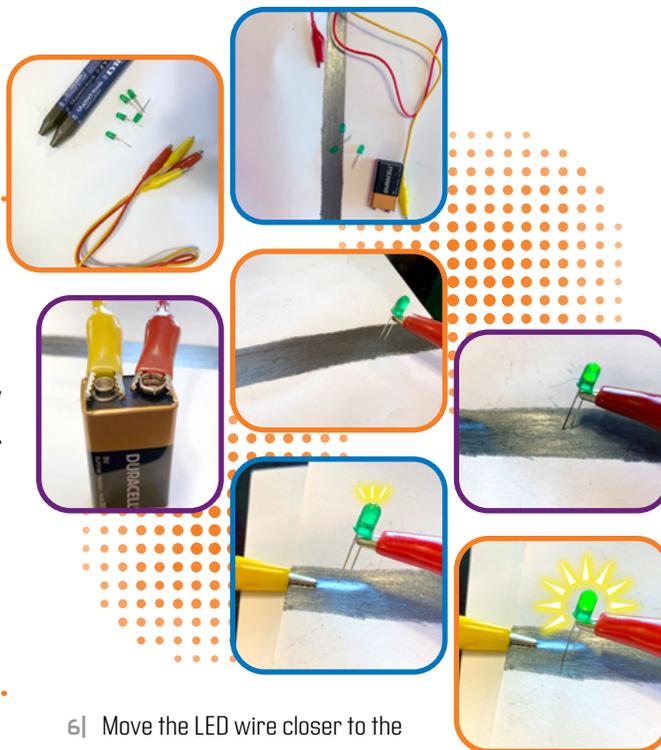
- >> This lab will target technology and engineering concepts.
- >> The objective of this lab is to be able to show the students the ideas of conductors and circuits:
 - Conductor: A type of material that allows flow of energy
 - Circuits: Individual components that are wired together that allow electrical currents to run
- >> Graphite can be used to create a circuit– a path for an electrical current.

Materials:

- >> Printer Paper
- >> Several Small LEDs
- >> Graphite pencil (#9b pencil is best)
- >> One (9) volt battery
- >> Two alligator clip test leads

Instructions:

- 1| On a piece of printer paper, draw a thick, black rectangle about .5 inch wide and 1.5 inch long using the graphite pencil. Color it in and layer the color a couple of times to create a thick layer of graphite. Make sure all spaces are filled.
- 2| Connect one end of each of the alligator clips to one of the battery terminals.
- 3| Clip the other end of the alligator clip that is attached to the positive side of the battery to the long leg of an LED bulb.
- 4| Touch the free wire of the LED bulb to the right side of the graphite bar that was drawn.
- 5| Touch the alligator clip attached to the negative side of the battery terminal to the left side of the graphite bar that was drawn.



- 6| Move the LED wire closer to the alligator clip to see what happens. The light should get brighter as you decrease the distance. Try not to touch the bulb directly to the clip.
- 7| If the bulb doesn't light up, switch the positive alligator clip to the other leg of the LED bulb and try again. If it still doesn't work, make sure there are no gaps in the line you drew and then try a different LED.

Supporting Science:

- >> This lab is based on the concept of **conductors** of electricity which allow **electrons** to flow through them and create an **electric current**.



- >> Graphite, a crystalline form of carbon, is a **conductor**.
- >> The graphite layer will allow a circuit to be created in which **electrons** can flow from the battery and into the bulb.
- >> The circuit must be continuous in order for the **electrons** to flow all the way through the path.

Jobs associated with this Lab:



Electrical Engineer

- >> Design and develop new electrical systems, solve problems and test equipment. Study and apply the physics and mathematics of electricity, electromagnetism and electronics to both large and small scale systems to process information and transmit energy.
- >> Education: Bachelor's or Master's in Electrical Engineering or related field
- >> Salary: \$82,380 / Growth: 27.5%

Biomedical Engineer

- >> Design biomedical equipment and devices, such as artificial internal organs, replacements for body parts, and machines for diagnosing medical problems. Install, adjust, maintain, repair, or provide technical support for biomedical equipment.
- >> Education: Bachelor's or Master's in Biomedical Engineering or related field
- >> Salary: \$72,965 / Growth: 13%

Industrial Engineer

- >> Engineering that focuses on the optimization of industrial systems and processes.
- >> Education: Bachelor's and Master's degree in Industrial Engineering
- >> Salary: \$89,890 / Growth: 13.8%

Electrician

- >> Install, maintain and repair electrical control, wiring, and lighting systems.
- >> Education: High School Diploma or equivalent
- >> Salary: \$37,470 / Growth: 40%

Quiz:



- 1| **What flows through the conductors to create electricity?**
 - a. Neutrons
 - b. Protons
 - c. Light
 - d. Electrons

- 2| **We use graphite in this experiment. What are its physical and chemical properties?**

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- 3| **Make some new drawing with the graphite pencil. Can the electrical currents travel around corners or curves?**

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- 4| **What happens if you erase part of the drawing to create a gap?**

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- 5| **What is a conductor?**
 - a. A material that allows for charge to be transferred through the whole object
 - b. A material that allows for charge to be transferred only through half of the object
 - c. A material that cancels all charge
 - d. A material that allows two charges to charge between the two



LAVA LAMP

Objective:

- >> This lab is based on the concept of **density**.
- >> The objective of this lab is to visually show how liquids of different densities will react with each other and with air.
- >> The end goal of this experiment is to create a lava lamp that can be reused in the future.

Materials:

- >> Empty water bottle*
- >> Water
- >> Vegetable oil
- >> Food coloring
- >> Alka-Seltzer tablet

**Other ordinary glass cups can be used but a water bottle with a screw-on cap will ensure the experiment can be reused in the future*

Instructions:

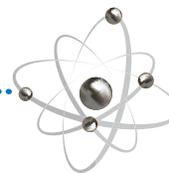
- 1] Pour water into the empty bottle so that water fills up 1–2 inches of the bottom of the bottle.
- 2] Add a few drops of food coloring into the water and gently mix the solution together.
- 3] Carefully pour vegetable oil on top of the layer of water so that $\frac{2}{3}$ of the bottle is not filled with liquid; only $\frac{1}{3}$ is filled with a layer of oil and water.



- 4] The water and the oil should separate into 2 distinct layers.
- 5] Allow the two layers time to separate so that the colored water has settled to the bottom.
- 6] Once settled, drop an Alka-Seltzer tablet into the bottle and allow the bubbles to form and rise up.
- 7] The end result should be a lava lamp with colored bubbles rising up through the layer of oil and then gradually falling back down.



Supporting Science:



- >> The water and the oil will separate into layers due to the fact that they have different **densities**.
- >> The water, with a higher density, will be on the bottom while the lower density oil layer will float on top of the water.
- >> The Alka-Seltzer tablet, with the highest density, will sink all the way to the bottom and begin to create bubbles in the water layer.
- >> The bubbles formed in the water layer will then trap the colored water and appear as spheres of that chosen color.
- >> These contained bubbles will then rise up through the oil layer until they reach the exposed top at which point any gas will be **released**.
- >> After this, the colored spheres will then sink back down as there is no gas to lower the density.
- >> This process will continue until the tablet runs out and can be repeated by adding another tablet.

Jobs associated with this Lab:



Electrical Engineer

- >> Design and develop new electrical systems, solve problems and test equipment. Study and apply the physics and mathematics of electricity, electromagnetism and electronics to both large and small scale systems to process information and transmit energy.
- >> Education: Bachelor's or Master's in Electrical Engineering or related field
- >> Salary: \$82,380 / Growth: 27.5%

Pharmacist

- >> Focus on safely preparing and monitoring medication.
- >> Education: Pharm. D, Pharmacy school
- >> Salary: \$133,450 / Growth: 13.1%

Clinical Laboratory Technician

- >> Perform the laboratory tests that are crucial to the identification, diagnosis, and treatment of diseases.
- >> Education: Bachelor's degree in Biomedical Sciences
- >> Salary: \$46,680 / Growth: 22.3%

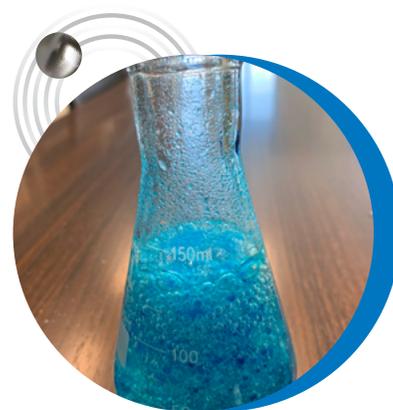
Quiz:



- 1| **What has a higher density?**
 - a. Water
 - b. Oil
 - c. Food coloring
 - d. Gas
- 2| **Density is affected by temperature. Please complete the following sentence.**

The hotter the liquid is, the _____ dense it is.

 - a. More
 - b. Less
 - c. Same
 - d. N/A
- 3| **What prevents the water and oil to mix together?**
 - a. Polarity
 - b. Temperature
 - c. Weight
 - d. Mass
- 4| **What is the scientific equation for density?**
 - a. Mass/volume
 - b. Mass x Volume
 - c. 1/volume
 - d. 1/mass
- 5| **When the Alka-Seltzer is added to the mixture it reacts with the water to create what chemical gas?**
 - a. Oxygen
 - b. Carbon Dioxide
 - c. Nitrogen
 - d. Helium





MILK COLOR WHEEL

Objective:

- >> This lab is based on the concept of polarity:
 - **Polar molecules** have uneven distribution of charged particles and are therefore attracted to other charged molecules.
 - **Non-polar molecules** generally have even charge distribution and are similarly attracted to other non-charged molecules.
 - **Bipolar molecules** have areas that display both characteristics and therefore attract different molecules to each of their unique regions.
- >> The objective of this lab is to visually show how polarity can affect what a substance is attracted to and how it travels in solution to reach molecules it is attracted to.

Materials:

- >> Water
- >> 3 droppers
- >> 3 different food colorings
- >> Dish soap
- >> 3 small cups
- >> Q-tip (cotton swab)
- >> Milk
- >> Plate or bowl to hold liquid



Instructions:

- 1] Add a small amount of water to each of the three cups.
- 2] In each cup, add a different color food coloring.
- 3] In the larger bowl or plate, pour enough milk to completely cover the bottom.
- 4] Use the droppers to add each colored water into the center of the milk.
- 5] Add a few drops of each color next to each other in the center.
- 6] On the side, take a cotton swab and dip it into dish soap.
- 7] Lightly touch the end with dish soap into the center of the milk where the colors are located.
- 8] Watch as the colors spread out and combine to create a unique colored pattern.

Supporting Science:



- >> This experiment is based on the physical and chemical properties of the milk and dish soap.
- >> Milk is made of water and **lipids (fats)** and the dish soap is made of a **bipolar molecule** that can surround the fat molecules and help separate them from the water.
- >> Once added to the milk, the soap will move through the solution and begin to target the fat molecules.
- >> As it moves towards these molecules in the milk, it will carry the color with it as it moves.
- >> The color allows us to see the soap molecules moving throughout the milk over time.

Jobs associated with this Lab:



Pharmacist

- >> Focus on safely preparing and monitoring medication.
- >> Education: Pharm. D, Pharmacy school
- >> Salary: \$133,450 / Growth: 13.1%

Medical Scientist / Researcher

- >> Carries out academic or scientific research. The subject can vary throughout the region or school, most research is on medical concepts– cancer, Alzheimer’s, Parkinson’s, genetic mutations.
- >> Education: Master’s or PhD in the science field
- >> Salary: \$60,360 / Growth: N/A

Clinical Laboratory Technician

- >> Perform the laboratory tests that are crucial to the identification, diagnosis, and treatment of diseases.
- >> Education: Bachelor’s degree in Biomedical Sciences
- >> Salary: \$46,680 / Growth: 22.3%

Phlebotomist

- >> Trained to draw and collect blood from patients.
- >> Education: Certification and years of experience to properly draw the blood
- >> Salary: \$30,110 / Growth: 25%

Surgical Technologist

- >> Help surgeons, nurses, and other members of the surgical team before, during, and after surgical procedures.
- >> Education: Associates degree and clinical training
- >> Salary: \$45,160 / Growth: 12.8%

Quiz:



1| What are the physical characteristics of the milk?

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2| What is the difference between polar and non-polar molecules?

- a. In polar bonds, there is an electronegativity difference, while in non-polar bonds they are equal
- b. Polar bonds are equal to non-polar bonds
- c. In polar bonds the electronegative charge is equal, while in non-polar there is a difference
- d. None of the above

3| What is the charge of electrons?

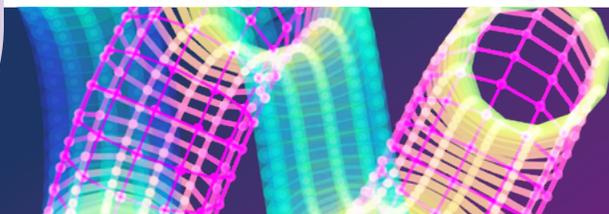
- a. Positive
- b. Negative
- c. No charge

4| Why is soap added in this experiment?

- a. It’s polar and lets the colors change
- b. It’s Hydrophobic
- c. It’s Hydrophilic
- d. To make it bubbly

5| Is milk considered an Acid, Neutral, or Base?

- a. Acid
- b. Base
- c. Neutral





METALLIC EGG

Objective:

- >> This lab will focus on hydrophilic and hydrophobic concepts.
 - **Hydrophobic** properties refers to things that molecularly and chemically refrain from binding to water when in solution.
 - **Hydrophilic** properties refers to that molecularly and chemically are attracted to water and bind easily to it.
- >> The objective of this lab is to put into practice this concept and visually show how a hydrophobic object will react with water and light.
 - **Reflection:** When light is not absorbed by the object and is thrown (reflected) back.
 - **Refraction:** When light's direction and speed is changed when going through an object causing some distortion.

Materials:

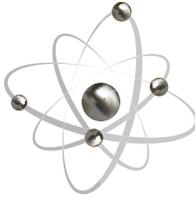
- >> Egg
- >> Candle
- >> Lighter
- >> Oven mitts
- >> Tongs
- >> A stand to place egg on
- >> Glass large enough to place egg in
- >> Water



Instructions:

- 1| Place the egg on top of the stand.
- 2| Place the candle underneath the egg on the stand. Alternatively you can use the tongs to hold the egg.
- 3| Light the candle and let it burn the egg.
- 4| Rotate the egg carefully using the tongs and oven mitts until all sides of the egg have been charred.
- 5| Once the egg is fully charred, let it cool down .
- 6| As the egg is cooling, fill a glass with water.
- 7| Place the charred egg into the water using the tongs.
- 8| Watch as the charred egg reacts with the water.

Supporting Science:



- >> This experiment works due to the fact that the newly burnt egg displays **hydrophobic** properties.
- >> Once you char the egg, it gets coated in a layer of soot, which is **hydrophobic**.
- >> When the charred egg is placed into the glass of water a layer of air forms around the egg due to the fact that the water will not mix with the soot.
- >> Light then shines onto this layer of air and **reflects** back, giving the egg the appearance that it is metallic.

Jobs associated with this Lab:



Electrician

- >> Install, maintain and repair electrical control, wiring, and lighting systems.
- >> Education: High School Diploma or equivalent
- >> Salary: \$37,470 / Growth: 40%

Clinical Laboratory Technician

- >> Perform the laboratory tests that are crucial to the identification, diagnosis, and treatment of diseases.
- >> Education: Bachelor's degree in Biomedical Sciences
- >> Salary: \$46,680 / Growth: 22.3%

Quiz:



- 1| In this experiment, the “soot” around the egg is made of carbon particles. Are they hydrophobic or hydrophilic?
 - a. Hydrophobic
 - b. Hydrophilic
 - c. None of the above
- 2| What is the difference between hydrophilic and hydrophobic?
 - a. Hydrophilic repels water while hydrophobic attracts water
 - b. Hydrophilic attracts water while hydrophobic repels water
 - c. They both attract water
 - d. They both repel water
- 3| When looking at the egg in the water, it seems to have a metallic finish. What light concepts causes this phenomenon?
 - a. Reflection of the soot in the water
 - b. Refraction of the light waves moving from the water to air
 - c. The soot has a chemical reaction with the water
 - d. None of the above
- 4| What is the difference between reflections and refractions?

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- 5| What physical properties change in the egg during the experiment?

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ELEPHANT TOOTHPASTE

Objective:

- >> This lab is based on the concept of chemical reactions.
- >> Some important concepts to define are:
 - **Chemical reaction:** The result of mixing two or more chemicals together in a confined environment.
 - **Exothermic reaction:** A reaction that gives off heat as the reaction progresses.
 - **Gas evolution reaction:** Any chemical reaction that produces some form of gas as an end product.
 - **Endothermic reaction:** A reaction that causes an absorption of heat.
- >> To safely perform a chemical reaction.

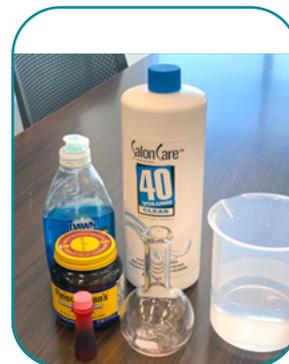
Materials and PPE:

- >> Hydrogen peroxide
- >> Dish soap
- >> Food coloring
- >> Yeast
- >> Flask or other narrow glass bottle*
- >> Water
- >> Small cup or bowl
- >> Place mat or tarp to contain experiment
- >> Gloves
- >> Apron
- >> Safety Goggles

**Do not use plastic bottle as heat may cause it to melt*

Instructions:

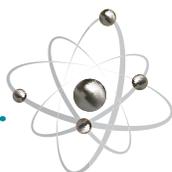
- 1| First grab the larger glass bottle.
- 2| Add hydrogen peroxide, dish soap, and food coloring to the bottle in no particular order so that the total volume takes up the bottom inch of the bottle.
- 3| Gently swirl together to mix the solution without creating any bubbles with the dish soap.
- 4| In a separate bowl, mix yeast together with warm water.
- 5| Carefully pour the yeast solution from the bowl into the glass bottle that contains the solution.
- 6| Step away and observe as the chemical reaction occurs.



SAFETY WARNINGS:

- >> This reaction is exothermic and will generate a substantial amount of heat, please keep a safe distance as the reaction occurs and allow it time to cool down afterwards.
- >> The reaction will produce a substance that can stain skin and clothing so please wear gloves, safety goggles and an apron when performing the reaction.
- >> The reaction can be very forceful and cause the end product to shoot out of the bottle and into the air so please ensure either a tarp to catch the product or carry it out in an outdoor environment with plenty of space.

Supporting Science:



- >> This experiment is based on the chemical **reaction** between hydrogen peroxide and yeast.
- >> This **reaction** is an **exothermic** and a **gas evolution** reaction.
- >> As the **reaction** progresses, a significant amount of gas is produced.
- >> The dish soap in the mixture acts as a **micellar** component that captures the gas as it tries to escape.
- >> The dish soap will capture the gas in the form of a bubble-like substance.
- >> The food coloring helps us track the gas and see the bubble-like substance from a safe viewing distance as it is expelled from the glass bottle that contains the **reaction**.

Jobs associated with this Lab:



Medical Scientist / Researcher

- >> Carries out academic or scientific research. The subject can vary throughout the region or school, most research is on medical concepts– cancer, Alzheimer’s, Parkinson’s, genetic mutations.
- >> Education: Master’s or PhD in the science field
- >> Salary: \$60,360 / Growth: N/A

Clinical Laboratory Technician

- >> Perform the laboratory tests that are crucial to the identification, diagnosis, and treatment of diseases.
- >> Education: Bachelor’s degree in Biomedical Sciences
- >> Salary: \$46,680 / Growth: 22.3%

Phlebotomist

- >> Trained to draw and collect blood from patients.
- >> Education: Certification and years of experience to properly draw the blood
- >> Salary: \$30,110 / Growth: 25%

Quiz:



1| What is the definition of a catalyst?

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2| Of the materials used in the experiment, which one is a catalyst?

- a. Water
- b. Yeast
- c. Hydrogen Peroxide
- d. Dish Soap

3| Why is dish soap used in this experiment?

- a. The micellar traps the oxygen creating immense bubbles
- b. Creates heat in the experiment
- c. Makes it fluffy
- d. Changes the scent

4| What is the difference between endothermic and exothermic reactions?

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5| Will using a strong hydrogen peroxide percentage change the end result?

- a. Yes
- b. No
- c. I need more information



STRAWBERRY DNA EXTRACTION

Objective:

- >> This lab is designed to guide students in extracting DNA from strawberries.
- **Deoxyribonucleic acid (DNA)** is a molecule that encodes genetic material for organisms and is contained within each cell of the organism.
- >> In this lab, students will break open the cells of the strawberry and isolate the DNA that is released from each cell.

Materials:

- >> Plastic Ziploc bag
- >> 2 plastic cups
- >> 2 strawberries (fresh or frozen)
- >> Coffee filter
- >> Dish soap
- >> Ice cold rubbing alcohol
- >> Water
- >> Coffee stirrer



SAFETY WARNINGS:

- >> Although this experiment is derived from strawberries, the added materials can be toxic so please refrain from ingesting any strawberry pulp at the end.

Instructions:

- 1| Remove any green leaves or stems from the strawberries before beginning.
- 2| Place the strawberries into the plastic bag and tightly seal it off.
- 3| Gently mush the strawberries into a pulp while in the bag and be careful not to puncture any holes in the bag while pressing down.



- 4| In one of the cups, add 2 teaspoons of dish soap, 1 teaspoon of salt, and half a cup of water. Label this cup as "Extraction Liquid" and set aside.
- 5| Carefully open the bag and pour 2 teaspoons of the Extraction Liquid into the bag.
- 6| Reseal the bag and carefully mush the mixture for 1 minute while avoiding making too many soap bubbles.
- 7| Using a coffee filter, filter the liquid from the plastic bag into the other cup and discard of any strawberry pulp that remains in the filter.
- 8| Gently pour an equivalent amount of chilled alcohol into the cup and do not stir or mix.
- 9| After a few moments, a white layer should form on the surface of the liquid.
- 10| Use the coffee stirrer to carefully remove the white layer (this white layer is the extracted DNA).

Supporting Science:



- >> This experiment is based on the **lysing** (or breakdown) of the strawberry cells and the isolation of the internal DNA.
- >> The soap, salt, and water will create a solution that will break down the **fatty membrane** that surrounds the cell, allowing the DNA to flow freely in the mixture.
- >> The alcohol then causes the DNA to chill, clump together, and **precipitate** out of solution.
- >> The colder the alcohol, the more DNA that will **precipitate** out.

Jobs associated with this Lab:



Phlebotomist

- >> Trained to draw and collect blood from patients.
- >> Education: Certification and years of experience to properly draw the blood
- >> Salary: \$30,110 / Growth: 25%

Clinical Laboratory Technician

- >> Perform the laboratory tests that are crucial to the identification, diagnosis, and treatment of diseases.
- >> Education: Bachelor's degree in Biomedical Sciences
- >> Salary: \$46,680 / Growth: 22.3%

Forensic Analyst

- >> Uses scientific knowledge in order to connect biological markers to important details in a crime.
- >> Education: Bachelor's in Forensic Science or related fields (Biology, Chemistry, etc.)
- >> Salary: \$58,000 / Growth: 17%

Epidemiologist

- >> Study the spread and prevalence of disease throughout a variety of global populations
- >> Education: Medical degree along with residency experience
- >> Salary: \$65,110 / Growth: 6%

Quiz:



1| What are genetics?

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2| What does DNA stand for?

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3| What reaction happens when the alcohol is added to the strawberry?

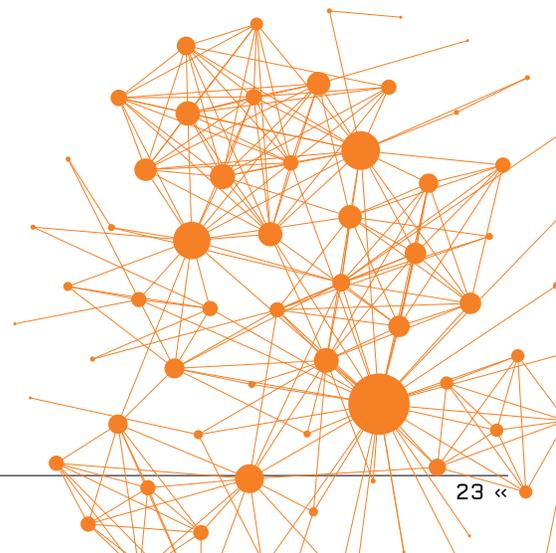
- a. Condensation
- b. Precipitation
- c. Evaporation
- d. None of the above

4| Where is most of the DNA located in a chromosome?

- a. Rough ER
- b. Smooth ER
- c. Nucleus
- d. Mitochondria

5| What are genes made up of?

- a. Flagella
- b. Acids
- c. Chemicals
- d. DNA





CABBAGE CHEMISTRY

Objective:

- >> This lab is based on the concept of **pH** and **pH indication**:
 - pH is a metric that is used to measure the acidity or basicity of a solution.
 - pH is directly defined as the concentration of Hydrogen Ions in a solution.
 - Low pH values reflect acidic conditions and high pH values reflect basic conditions.
- >> The objective of this lab is to measure the pH of a variety of household items and identify them as acidic or basic.

Materials:

- >> Red cabbage
- >> Several cups
- >> Lemon juice
- >> Water
- >> Hand sanitizer
- >> Baking soda
- >> Blender
- >> Sugar
- >> Sprite
- >> Strainer
- >> Vinegar
- >> Bleach

Instructions:

- 1| First you will need to create a pH indicator.
- 2| In a blender, add water and a handful of red cabbage.
- 3| Blend until the solution is somewhat watery.
- 4| Strain this mixture into a cup, separating the cabbage chunks from the liquid.
- 5| Carefully throw away the excess chunks (be sure not to spill them on your clothes as they will stain).
- 6| Label the cup with cabbage liquid as "Indicator", and set it aside.



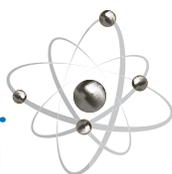
- 7| With the remaining glasses, create a mixture of each of the other ingredients mixed with water in their own cups.
- 8| Label each cup as the ingredient you placed in it. (Ex. Baking Soda, Sugar Water, etc.)



- 9| Arrange the cups by how acidic you think they are (most acidic on the right, least acidic on the left).
- 10| Add a small amount of indicator to each of these cups.
- 11| Gently swirl the cups to allow the indicator to properly mix.
- 12| Note the color change that occurs in each cup.
- 13| Based on the color change, arrange the cups by pH using the scale in the *Resources* section and take note on how many cups you were able to correctly predict after fixing the order.



Supporting Science:



- >> This experiment is based on the **acid** and **base** properties of many household solutions.
- >> Each liquid will have a different **pH** and the blended cabbage will serve as an indicator that will change colors depending on the **pH** of the mixture.
- >> By adding the cabbage solution to each mixture, it allows us to measure the **pH** of each mixture and identify which are **acidic** and which are **basic** based on the color that the mixture turns once the homemade indicator is added.

Jobs associated with this Lab:



Clinical Laboratory Technician

- >> Perform the laboratory tests that are crucial to the identification, diagnosis, and treatment of diseases.
- >> **Education:** Bachelor's degree in Biomedical Sciences
- >> **Salary:** \$45,990 / **Growth:** 22.3%

Environmental Engineer

- >> Discipline that takes from broad scientific topics like chemistry, biology, ecology, geology, hydraulics, hydrology, microbiology, and mathematics to create solutions that will protect and also improve the health of living organisms and improve the quality of the environment.
- >> **Education:** Bachelor's degree in Engineering concentrating in environment, chemical, and civil concepts
- >> **Salary:** \$86,510 / **Growth:** 10.1%

Chemist

- >> Uses the concepts of chemistry to research and develop scientific innovations usually in the medical field, oil and refining field, cosmetics industry and many other.
- >> **Education:** Bachelor's degree in Chemistry
- >> **Salary:** \$83,000 / **Growth:** 9.9%

Quiz:



1| What does pH scale measure?

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2| On a pH scale what would be considered acidic? Neutral? Basic?

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3| What are the chemical and physical properties of an acid? And of a base?

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4| How does pH relate to our daily life?

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5| What type of acid is found inside your body? And how does it work?

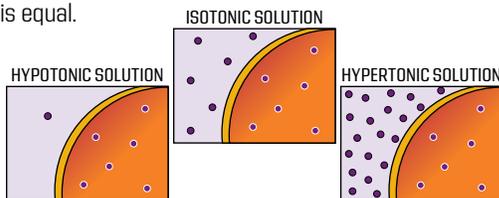
- a. Hydrobromic Acid, found in saliva to help break down food in mouth
- b. Hydrochloric Acid, found in stomach to break down food
- c. Both A & B
- d. None



THE DISSOLVING EGG

Objective:

- >> This lab will focus on biology concepts of **Osmosis**.
 - Osmosis is the net movement of water across a semi-permeable membrane.
- >> The students will learn the difference between **Hypotonic**, **Hypertonic** and **Isotonic**.
 - Hypotonic: The concentration of liquid is greater inside than the concentration of liquid outside. Causing the cell to lyse (burst).
 - Hypertonic: The concentration of liquid inside is less than the concentration of liquid outside. Causing the cell to shrivel.
 - Isotonic: The concentration of liquid inside and outside is equal.



- >> We will be manipulating the osmotic balance of the egg with different household items.

Materials:

- >> 3 eggs
- >> 3 glasses (large enough to fit the egg plus liquid)
- >> 3 butter knives
- >> White vinegar (about 3 cups)
- >> Distilled water (about 2 cups)
- >> Light corn syrup (about 1 ¼ cups)
- >> Slotted spoon
- >> Measuring cup (1 cup)
- >> Measuring spoons (1 tablespoon and ½ tablespoon)
- >> Sticky notes and marker
- >> Scale (optional)

Instructions:

- 1) Place one egg in each glass. Pour in enough vinegar to cover each egg. Bubbles will start to form around the egg, and it'll float up. To keep it submerged, put a butter knife in the glass to hold it down.
 
- 2) Put the three glasses in the refrigerator and allow to sit for 24 hours.
 
- 3) Gently holding the egg in the glass, pour out the old vinegar. Replace with fresh vinegar and let sit in the refrigerator for another 24 hours. Repeat this process until the shells are fully dissolved and only the membrane remains. This should take about 2–3 days.
- 4) Gently remove the eggs using the slotted spoon and rinse with tap water in the sink. Rinse out the empty glasses as well.
- 5) Gently put the shell-less eggs aside for a moment on a plate.
- 6) Prepare three different sugar-water solutions as follows, labeling with sticky notes:
 - Glass 1: Label "hypertonic". Pour in one cup of corn syrup.
 - Glass 2: Label "isotonic". Add 1 ½ tablespoons corn syrup to the one cup measuring cup and fill the remainder with distilled water. Pour into glass (make sure you get all the corn syrup out), and stir to dissolve.
 - Glass 3: Label "hypotonic". Pour in one cup of distilled water. Gently put one shell-less egg in each of the glasses, and let sit in the refrigerator for another 24 hours.

**Optional: If you have a scale that weighs in grams, weigh each egg before placing it in its respective solution*

| SOLUTION | STARTING WEIGHT (G) | ENDING WEIGHT (G) |
|------------|---------------------|-------------------|
| HYPERTONIC | | |
| ISOTONIC | | |
| HYPOTONIC | | |

- 7] Remove the glasses from the refrigerator, and gently put the eggs on a plate. If you weighed the eggs before putting them in each solution, weigh them again. What happened to each of the eggs?

8] End Results:



Jobs associated with this Lab:



Environmental Engineer

- >> Discipline that takes from broad scientific topics like chemistry, biology, ecology, geology, hydraulics, hydrology, microbiology, and mathematics to create solutions that will protect and also improve the health of living organisms and improve the quality of the environment.
- >> **Education:** Bachelor's degree in Engineering concentrating in environment, chemical, and civil concepts
- >> **Salary:** \$86,510 / **Growth:** 10.1%

Surgical Technologist

- >> Help surgeons, nurses, and other members of the surgical team before, during, and after surgical procedures.
- >> **Education:** Associates degree and clinical training
- >> **Salary:** \$45,160 / **Growth:** 12.8%

Clinical Laboratory Technician

- >> Perform the laboratory tests that are crucial to the identification, diagnosis, and treatment of diseases.
- >> **Education:** Bachelor's degree in Biomedical Sciences
- >> **Salary:** \$46,680 / **Growth:** 22.3%

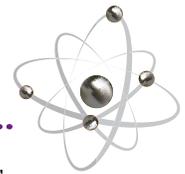
Pharmacist

- >> Focus on safely preparing and monitoring medication.
- >> **Education:** Pharm. D, Pharmacy school
- >> **Salary:** \$133,450 / **Growth:** 13.1%

Medical Scientist / Researcher

- >> Carries out academic or scientific research. The subject can vary throughout the region or school, most research is on medical concepts– cancer, Alzheimer's, Parkinson's, genetic mutations.
- >> **Education:** Master's or PhD in the science field
- >> **Salary:** \$60,360 / **Growth:** N/A

Supporting Science:



- >> In the case of the **hypertonic** solution, more solutes were in the corn syrup than in the egg. So, water flowed out of the egg and into the corn syrup, and as a result the egg shriveled up.
- >> In the case of the **isotonic** solution, roughly an equal amount of solutes were in the corn syrup/water solution as in the egg, so there was no net movement in or out of the egg. It stayed the same size.
- >> In the case of the **hypotonic** solution, more solutes were in the egg than in the pure water. So, water flowed into the egg, and as a result, it grew in size.

Quiz:



- 1] **What is the definition of hypotonic?**
 - a. The concentration of liquid is greater inside than the concentration of liquid outside.
 - b. The concentration of liquid is less inside than the concentration of liquid outside.
 - c. The concentration of liquid is greater the same as the concentration of liquid outside.
 - d. None of the above
- 2] **What happens when cells are hypertonic?**
 - a. They burst
 - b. They shrivel
 - c. They stay the same
 - d. None of the above
- 3] **What is the definition of osmosis, and how is it used in real life?**

.....

.....
- 4] **Is water hypertonic, hypotonic or isotonic?**
 - a. Hypertonic
 - b. Hypotonic
 - c. Isotonic
- 5] **What factors affect osmosis?**
 - a. Concentration of liquid
 - b. Temperature
 - c. Pressure
 - d. All of the above



SPIROMETER

Objective:

- >> This lab will target the concepts of biology in understanding one of the main and vital systems: The Respiratory system.
- >> It introduces the concepts of lung capacity and inhaling oxygen and exhaling Carbon Dioxide.
 - Total lung capacity, also known as TLC, is the total volume of air in the lungs after taking in a deep inspiration.
 - The average lung capacity is about 6 liters.

Materials:

- >> Large container (plastic or glass work)
- >> Water
- >> Plastic 2-liter container
- >> Straws (bendy straws)
- >> Marker

Instructions:

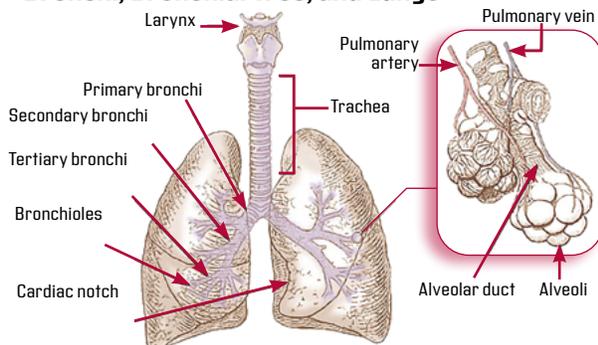
- 1] Fill large container with water; about 50%–75% filled.
- 2] Also fill your 2-liter container with water.
- 3] Attach a couple of bendy straws together to form one large tub that will be used in the water.
- 4] Carefully insert the straw inside the 2-liter container filled with water, leaving enough of the straw out so it can be used.
- 5] With adult help, flip the 2-liter container onto the large container filled with water, to where the 2-liter is upside down inside the water and the straw is sticking out to be used.
- 6] Start blowing into the straw, causing the water to be pushed out of the two liter container into the pool of water.
- 7] When you no longer can blow into the straw, use your marker to make a line where your water level is.
- 8] The amount of water pushed out is your lung capacity.



Supporting Science:

- >> This lab is based on the biology and anatomy concepts.

Bronchi, Bronchial Tree, and Lungs



- >> The **respiratory system** is vital to human living and this explores the way lungs function when **inhaling** and **exhaling**.
- >> Making sure the lungs are functioning correctly is very important in order to keep breathing and living.

Jobs associated with this Lab:



Veterinarian

- >> Diagnose, treat, and research medical conditions and diseases of pets, livestock, and other animals. Also treat illnesses and injuries.
- >> Education: Doctoral program, Veterinarian school
- >> Salary: \$134,860 / Growth: 24.5%

Nurse Practitioner

- >> Nurse practitioners are registered nurses who provide specialized health care, promote health, prevent and treat diseases and injuries, and help patients cope with illness.
- >> Education: Bachelor's of Nursing and certification along with 1–2 years of experience.
- >> Salary: \$109,260 / Growth: 40.7%

Physician Assistant

- >> Health care practitioner who practices medicine in collaboration with or under the supervision of a physician.
- >> Education: Professional Degree, PA School
- >> Salary: \$89,150 / Growth: 34.5%

Dentist

- >> Surgeon who specializes in preventing, diagnosing and treating any oral cavity health issues.
- >> Education: Dental School and Residency Program
- >> Salary: \$177,940 / Growth: 26.6%

Physician & Surgeon

- >> A medical doctor who helps in the treatment of patients. A surgeon is a doctor who is licensed to perform surgeries.
- >> Education: Medical School, Residency, Fellowship
- >> Salary: \$191,430 / Growth: 13.4%

Respiratory Therapist

- >> Cares for those with respiratory illnesses such as cystic fibrosis or asthma. Specializes in elderly patients with kidney failure.
- >> Education: Associates degree and clinical training
- >> Salary: \$55,800 / Growth: 26.5%

Biomedical Engineer

- >> Design biomedical equipment and devices, such as artificial internal organs, replacements for body parts, and machines for diagnosing medical problems. Install, adjust, maintain, repair, or provide technical support for biomedical equipment.
- >> Education: Bachelor's or Master's in Biomedical Engineering or related field
- >> Salary: \$72,965 / Growth: 13%

Quiz:



1| What is lung capacity?

- a. Volume of air in the lungs after an inspiration
- b. Volume of air in the lungs after expiration
- c. Volume of air in the lungs while holding your breath
- d. All of the above

2| What effects lung capacity?

- a. Gender
- b. Age
- c. Ethnicity
- d. All of the above

3| Please describe the Respiratory Cycle.

.....

.....

.....

.....

.....

4| What are the main functions of the lungs?

.....

.....

.....

.....

.....

5| Will an experienced runner have better lung capacity than an average human being?

- a. Yes
- b. No
- c. It depends

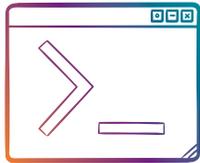


INTRO TO CODING

Computer science has become an emerging industry in our nation. As technology has become an integral part of life, the coding behind the programs we use every day is vital to making sure that everything runs smoothly. We don't realize it, but every software, app, or website we use on our phones, laptops and tablets are all designed and maintained with code!

What is coding?

Simply put coding is a set of rules or guidelines you can write to make a computer behave the way you want it to. However, there is not just one way



to write codes, in the past couple of decades different types of coding languages have been created for specific projects. As we go through more on coding essentials, we will be explaining all of the different languages and their purpose.

There are two types of development that coding is used for:

>> FRONT END DEVELOPMENT:

Front-end developers work on what is known on the user side. They are responsible for designing anything a user will see and interact with including but not limited to websites and apps.

>> BACK END DEVELOPMENT:

Back-end developers are the people working backstage making sure everything runs smoothly. They make sure that all the code and servers are speaking clearly to each other and that no glitches exist.

Learning the two types of development is very important because it allows you to understand what language is more appropriate for the job that you are trying to accomplish.



All code can be categorized into a type of "Language". This section is intended to provide an overview of a few of the most common types of coding languages.

>> PYTHON

This is one of the popular types of coding language as it is very simple to learn, and it creates simple commands. Due to it not being complex, usually Python is specifically used for back-end development. Well-known companies that use Python: Google, Pinterest, Instagram, and Dropbox.

>> JAVA SCRIPT

Java script is a language that is very popular right now due to its functionality. The ability to create a variety of complex videos to simple websites makes this language a shoe-in for front-end development. Currently, a software developer that is proficient in using Java Script is highly wanted in the workforce.

>> HTML

HTML is what essentially makes our world go around. If we didn't have HTML coding, we wouldn't be able to reach all of our favorite websites. HTML formats the text, pictures, video and sound for all websites. However, HTML is only the structure of a website, there is a need to work with other scripts like Java Script or CSS to run a functional website.

>> CSS

CSS works in partnership with HTML to create functioning websites. CSS creates a platform to design an attractive website to the viewer adding color and media.



>> RUBY

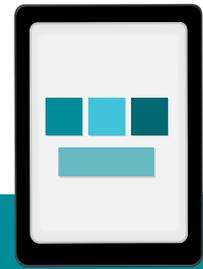
Ruby works on a completely different framework called *Ruby On Rails*. It is pretty easy to use and easy to comprehend; however, Ruby is usually much more compatible with an Android platform than any other. Many popular companies use Ruby as the development language including Twitter, Airbnb, and Shopify.

>> JAVA

Java should not be confused with Java Script, as they are very different languages. Java is a generic script that has been around for the last two decades. With its reliability and ease of use, it is usually the number one choice as a development language with about 90% Fortune 500 companies including Facebook, Yahoo and Amazon.

Computer science in the workforce?

Having computer science knowledge is now more and more essential when looking for jobs; however, in our region we are lagging in Computer Science jobs compared to other major cities in the nation. We are still not attracting Fortune 500 company headquarters or research labs, and we don't have a strong enough pool of tech startups to attract the number of talented young professionals that we need to get to the next level. Basically, we need more STEM jobs. Technology jobs. Technology is the future. At the MCA, we are working to fix this problem so that we attract more tech companies and grow more tech startups that will create these amazing jobs.



Computer Science Certifications

Computer science and the IT field is a booming industry, and it is constantly changing. A great way to keep up to date with new technologies is to take advantages of the online certifications available for everyone. These certifications are considered a vital part of the computer science field by acting as a stepping stone into higher education opportunities, gaining or advancing career opportunities or simply to be added to a resume.

Certifications are usually short online programs that focuses on a specific set of skills in the Computer Science industry. Subjects can vary from language essentials, IT and software development and how systems are properly engaged. Below you can find a number of free or paid certification opportunities.

>> COMPUTER SCIENCES COURSES:

edX

edX, a platform that hosts free computer sciences courses that are available all year around. Institutions that participate are Microsoft, Harvard, MIT, Stanford, Yale and many other prestigious schools. Courses are 6–8 week courses that offer a variety of difficulty in various subjects including basic coding languages like python and Java, as well as introduction into front and back-end development.

<https://www.edx.org/course/subject/computer-science>

Coursera

Another platform that offers a variety of courses from beginner to advanced skill levels. Coursera hosts online degrees, classes and certifications in many subjects including computer science. Many of the institutions that offer courses are accredited universities in the nation.

<https://www.coursera.org/browse/computer-science>

>> MICROSOFT CERTIFICATIONS:

Microsoft offers a variety of courses and exams to be formally be certified in certain computer science subjects. They range from beginning courses to advanced certifications for career advancing. Below are the beginner certifications, that after completion and passing the exam the certification is able to be added to resume.

For more information visit the following website:

<https://docs.microsoft.com/en-us/learn/certifications/browse/>

IT certifications:

- Microsoft MTA: Security Fundamentals
- MTA: Mobility and Device Fundamentals

Coding Languages Certifications:

- Microsoft MTA: Introduction to Programming Using Python
- MTA: Introduction to Programming Using Java
- MTA: Introduction to Programming Using HTML and CSS

Coding Data Certifications:

- MTA: Database Fundamentals

Development:

- MTA: Software Development Fundamentals
- MTA: HTML5 Application Development Fundamentals

The courses and exams are not free, however, Microsoft has various scholarship opportunities for students to access the material at a lower cost. Microsoft also offers alternative scholarships for students who are interested in a Computer Science degree or actively attending a higher education institution to pursue a computer science career. In addition, they offer scholarships to the following prestigious computer sciences conferences:

- >> [Grace Hopper Celebration of Women in Computing](#)
- >> [National Society of Black Engineers Conference](#)
- >> [Society of Hispanic Professional Engineers Conference](#)
- >> [Tapia Conference](#)

Careers in the computer science industry:.....

Software Developer

- >> Design, install, and test software systems that will help businesses be more efficient and provide better service.
- >> Education: Bachelor's degree in Computer Science
- >> Salary: \$94,880 / Growth: 37.3%

Web Developer

- >> Programmer who specializes in, or is specifically engaged in, the development of online applications using a client-server model.
- >> Education: Bachelor's degree in Computer Science
- >> Salary: \$65,820 / Growth: 25%

Database Administrator

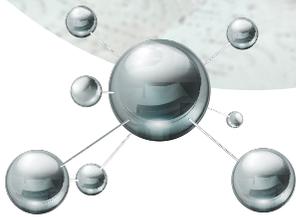
- >> Responsible for the organization and daily upkeep of complex computer networks.
- >> Education: Bachelor's and Master's Degree in Computer Science along with experience
- >> Salary: \$77,300 / Growth: 30.5%



Websites that provide free coding resources:.....

- >> [Scratch.mit.edu](#)
MIT has created a free website that has tutorials on learning different types of coding.
- >> [Hour of code](#)
Hour of Code is a non-profit organization whose mission is to create awareness of coding essentials. They provide hour tutorials and activities for students to learn coding.
- >> [Khan Academy](#)
Khan academy has instructional based videos led by professors to teach the basics of coding.
- >> [Free Code Camp](#)
As the name suggests, Free Code Camp is a platform that has over 6,000 tutorials on coding. You can practice real-time by working step by step to learn coding essentials. It has tutorials on all coding languages.

CONCLUSION / WRAP UP



Congratulations, you have finished the workbook! We hope that you had fun while learning some integral STEM concepts and how they all connect to the real world. The concept of this workbook was to create that connection between the science you are learning in the classroom and the workforce you will one day join.

The life sciences industry workforce is ever-growing and vital in our nation, as it is the backbone of what keeps our community running. As you grow up and figure out what you want to do with the rest of your life, we encourage you to look at the life sciences industry in its entirety. You can find a plethora of careers that will only keep growing and continue being an integral part of our workforce.

For more information on the life-sciences industry or the El Paso Workforce, please visit the following websites:

www.mcamericas.org

<https://www.borderplexjobs.com/>

Due to COVID-19 restrictions, we are unable to offer class tours of our building at this time. But we would be happy to offer a guest lecture in your classroom to talk about all the opportunities held in the life science field.

For more information or to book someone from the MCA to speak to your class, please contact:

Vianey Romo, Workforce Coordinator

vianey@mcamericas.org

RESOURCES

Periodic Table of the Elements

GROUP 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

PERIOD 1 2 3 4 5 6 7

18

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COLOR CODE

- Metal (Blue)
- Metalloid (Purple)
- Nonmetal (Orange)
- Solid (Grey)
- Liquid (Light Blue)
- Gas (Red)

Atomic Number →

Symbol →

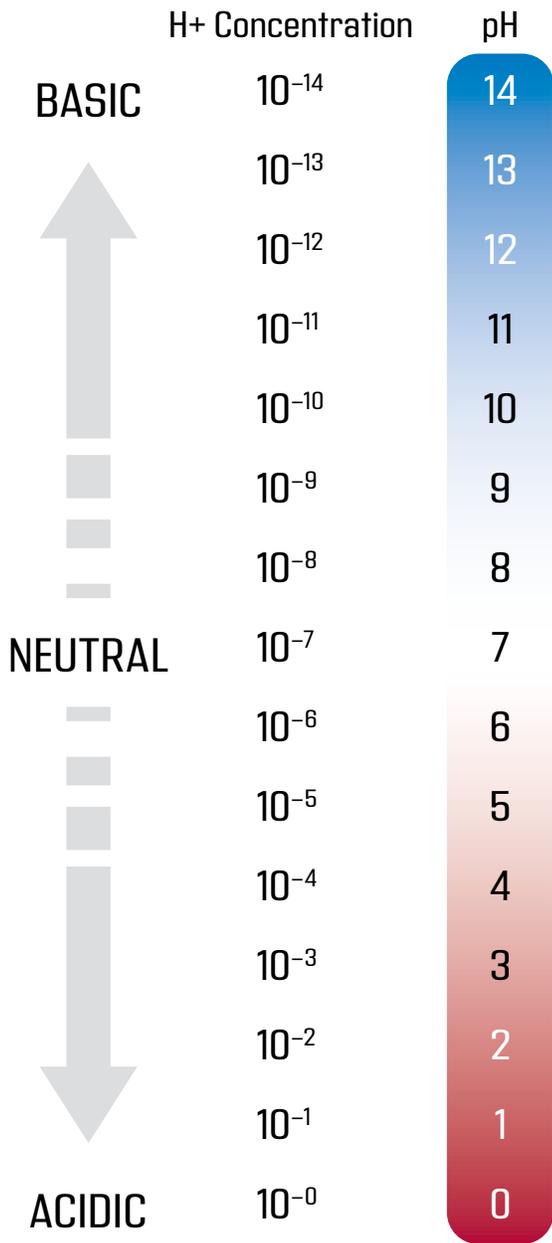
Atomic Mass ←

Name ←

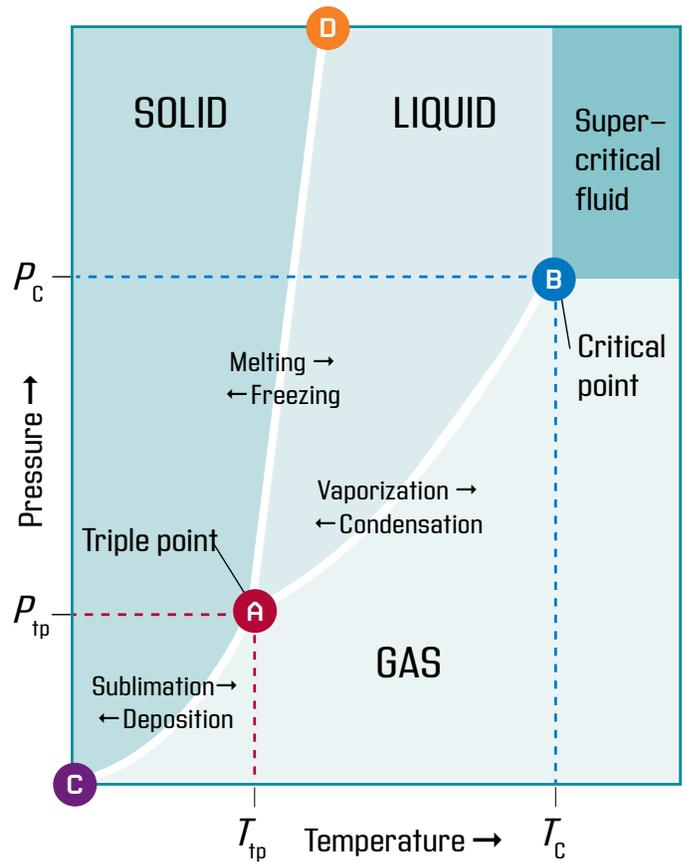
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pH Indicator Scale



Phase Diagram



Respiratory Diagram

| | SEQUENCE OF EVENTS | CHANGES IN ANTERIOR-POSTERIOR AND SUPERIOR-INFERIOR DIMENSIONS | CHANGES IN LATERAL DIMENSIONS |
|-------------------|---|--|-------------------------------------|
| EXPIRATION | 1) Inspiratory muscles relax (diaphragm rises; rib cage descends due to recoil of costal cartilages). | <p>Ribs and sternum depressed as external intercostals relax.</p> <p>Diaphragm moves superiorly as it relaxes.</p> | <p>External intercostals relax.</p> |
| | 2) Thoracic cavity volume decreases. | | |
| | 3) Elastic lungs recoil passively; intrapulmonary volume decreases. | | |
| | 4) Intrapulmonary pressure rises (to +1 mm Hg). | | |
| | 5) Air (gases) flows out of the lungs down its pressure gradient until intrapulmonary pressure is 0. | | |

Answer Key

Why so Salty?

- 1| B
- 2| Solid, granular, white, feels rough, at closer look grains appear less opaque
- 3| The removal of salts and minerals from water
- 4| **Freshwater:** Water with <1% of salt
Saltwater: Water containing a high concentration of salts and other minerals
- 5| Evaporation, Convection, Precipitation and Collection.

Color Magic

- 1| A
- 2| C
- 3| If a fatty medium like milk were to be used, there would be a much more different interaction due to the different molecules and polarity present in the milk. If tested out, it is observed that the colors move slower.
- 4| (This answer varies by student and by experiment performed.)
- 5| The pipe cleaner acts as an absorbing medium for the water to move up and into the filter.

Drinking Candle

- 1| The pressure lowers inside the glass, resulting in the pressure from the atmosphere pushing itself and the water into the glass.
- 2| A
- 3| A
- 4| C
- 5| Boyle's Law, Charles's Law, and Avogadro's Law

Graphite Circuit

- 1| D
- 2| **Physical:** dark in color (black/dark gray), kind of soft, slippery feel, solid
Chemical: high melting point, high electrical and thermal conductivity
- 3| This answer varies by student, but if enough graphite is used to create curves the electricity should flow properly.

- 4| If the "circuit" breaks, the electric current will also break, and the LED light bulb will not turn on.

- 5| A

Lava Lamp

- 1| A
- 2| B
- 3| A
- 4| A
- 5| B

Milk Color Wheel

- 1| White, liquid, fat content can make it less/more viscous
- 2| D
- 3| B
- 4| C
- 5| A

Metallic Egg

- 1| A
- 2| B
- 3| A
- 4| Reflection happens when light is absorbed and reflected back. Refraction is when the speed and direction of the light is changed causing distortion in its view.
- 5| The outside becomes charred and turns black/gray in color. It is no longer matte; it has a shiny look when inserted in water.

Elephant Toothpaste

- 1| A catalyst is some sort of material that when added to a reaction it increases the speed of the chemical reaction.
- 2| B
- 3| A
- 4| An endothermic reaction absorbs heat while an exothermic reaction releases heat.
- 5| A

Strawberry DNA Extraction

- 1| Genetics is a branch of science that focuses of the study of genes. Genes are what make a person who they are. Genes are made up of DNA.

- 2| Deoxyribonucleic Acid

- 3| B

- 4| C

- 5| D

Cabbage Chemistry

- 1| A pH scale indicates whether a compound is acidic, neutral or basic.
- 2| On a pH scale, anything below a 7 would be considered acidic, a 7 would be considered neutral and anything over 7 would be considered basic.

- 3| **Acid:** Sour, Sticky, Reacts with Metals
Base: Bitter, No smell, Slippery, Reacts with oils and fats

- 4| D

- 5| B

The Dissolving Egg

- 1| A

- 2| B

- 3| Osmosis is the net movement of water across a semi-permeable membrane. Osmosis is part of everyday life in plants and humans. In plants, it allows for the absorption of water, while in humans, it is used as the main function of kidney dialysis. It also allows the removal of minerals like salt when Osmosis is reversed.

- 4| B

- 5| D

Spirometer

- 1| A

- 2| D

- 3| The respiratory cycle, also known as the breathing cycle, has the two phases: Inspiration (inhaling) and Expiration (exhaling). When you inhale, the lungs expand, and as you exhale, your lungs contract. Each time you inhale and exhale is considered one breath.

- 4| The lungs play a vital role in everyday life and in keeping the human body regulated. The lungs work together to be able to keep you breathing by inhaling Oxygen and exhaling waste like Carbon Dioxide.

- 5| A

OTHER LIFE SCIENCES CAREERS NOT COVERED



Massage Therapist:

- >> Provide medical benefits to their clients, treating disorders of the human body or helping them recover from injuries. Also promotes relaxation.
- >> Education: License in Massage Therapy
- >> Salary: \$49,040 / Growth: 29.5%

Mental Health Counselor

- >> Identify and treat mental and emotional disorders and promote mental health. Help clients address issues such as depression, stress, anxiety, suicidal impulses, low self-esteem, addiction and substance abuse, trauma, and grief.
- >> Education: Associates degree or clinical training
- >> Salary: \$48,100 / Growth: 25.3%

Medical Social Worker

- >> Help patients and their loved ones adjust and adapt to the changes and losses brought on by illness or injury
- >> Education: Bachelor's in Health Science
- >> Salary: \$90,490 / Growth: 26.4%

Speech/Language Therapist

- >> Assess, diagnose, and treat people with voice disorders including speech, language, cognitive-communication, and fluency irregularities.
- >> Education: Associates degree and clinical training
- >> Salary: \$80,210 / Growth: 25.8%

Public Relations Specialist

- >> Create and maintain a favorable public image for the organization they represent. Craft media releases and develop social media programs to shape public perception of their organization and to increase awareness of its work and goals.
- >> Education: Bachelor's degree in Communications/Marketing and a few years of experience
- >> Salary: \$90,520 / Growth: 17.5%

Clinical Department Manager

- >> Take responsibility for one department of the institution and report status to senior level executives.
- >> Education: Bachelor's degree in Healthcare Administration and in special cases a Master's degree is recommended
- >> Salary: \$90,490 / Growth: 26.4%

Accountants and Auditors

- >> Prepare and examine financial records. Ensure that financial records are accurate and that taxes are paid properly and on time. Assess financial operations and work to help ensure that organizations run efficiently.
- >> Education: Bachelor's degree in Accounting
- >> Salary: \$62,310 / Growth: 16.7%

Financial Manager

- >> Produce financial reports, direct investment activities, and develop strategies and plans for the long-term financial goals of their organization.
- >> Education: Bachelor's degree in Economics or Math
- >> Salary: \$105,640 / Growth: 25.3%

First-Line Supervisors of Production and Operating Workers

- >> Directly supervise and coordinate the activities of production and operating workers, such as inspectors, precision workers, machine setters and operators, assemblers, fabricators, and plant and system operators
- >> Education: High school diploma or equivalent
- >> Salary: \$46,260 / Growth: 4.9%

Chief Nursing Officer (CNO)

- >> Ensure the quality of daily patient care and services
- >> Education: Registered Nurse License and often times a Master of Health Administration
- >> Salary: From \$85,000 to \$192,000
- >> Growth: Every hospital requires this position. As the number of hospitals grows, so does the need for this career.

Chief Executive Officer (CEO)

- >> Serves as the head of the organization and oversees all major decisions and operational changes. Maintains the standards of the institution and ensures that all members are in place.
- >> Education: Master's degree in Business Administration or Hospital Administration and many years of experience.
- >> Salary: Starts at \$245,819 / Growth: 2.1%

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OTHER RESOURCES

STEM : To learn more information about the various STEM initiatives taking place in the El Paso region or to explore other science experiments please visit the following websites. They offer amazing resources for students, teachers and parents.

- >> <https://sttefoundation.org/>
- >> <https://www.creed.org/stem-accelerator.html>
- >> <https://amino.bio/>
- >> <https://www.sciencefun.org>

Workforce: The following websites are awesome resources to learn more about local job statistics in different industries around our region. In addition, we have included the MCA and Bio-EPJ websites to learn more about our initiatives in fostering the growth of the life sciences industries through innovation.

- >> <https://www.borderplexjobs.com/>
- >> bls.gov/oes/current/oes_21340.htm
- >> www.mcamericas.org
- >> www.bioelpasojuarez.org

Books: If you liked our workbook and would like to find books with a similar feel, the following books are great resources to add. They all include DIY STEM experiments but also have some more intricate science that can be done in the classroom.

- >> *Smithsonian Science!* by Abigail Beall, Jack Challoner, Adrian Dingle, Derek Harvey, Bea Parks
- >> *STEAM Lab for Kids: 52 Creative Hands-On Projects for Exploring Science, Technology, Engineering, Art, and Math* by Liz Lee Heinecke
- >> *TIME For Kids Big Book of Science Experiments: A step-by-step guide* by editors of *Time for Kids* magazine
- >> *Mark Twain – STEM Labs for Middle Grades, Grades 5-8* by Schyrlet Cameron
- >> *Zero to Genetic Engineering Hero: The Beginners Guide to Programming Bacteria at Home* by Julie Legault and Justin Pahara

Higher education is more accessible now than ever before. Please visit our local higher education institutions website for more information on STEM related degrees:

- >> The University of Texas at El Paso (UTEP)
- >> El Paso Community College (EPCC)
- >> Texas Tech Health Science Center in El Paso (TTHSCEP)
- >> The University of Texas at Houston School of Public Health, El Paso Campus

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ABOUT THE AUTHORS



Pierce Davis is a current junior at Stanford University studying Human Biology with a concentration in Neurobiological Disorders and Public Health. He is a member of the George Lab in the Neurology and Neurological Sciences department at Stanford Medical School where he helps conduct stem cell research. Pierce did his first internship during the summer between high school and college. During the summer of 2020, Pierce served as a Donald Kennedy Public Service Fellow with Stanford University in partnership with the Medical Center of the Americas Foundation in El Paso. In the past, Pierce was a research assistant at the University of Texas at El Paso, graduated from El Paso High School as valedictorian, and is a recipient of The Gates Scholarship.



Vianey Romo is the Workforce Coordinator at the MCA where her responsibility is to work with the k-12 education pipeline in promoting the healthcare workforce in the Paso del Norte Region. She hosts STEM camps for middle school students at the MCA. She graduated cum laude from the University of Texas at El Paso, with a degree in Biological Sciences with a Biomedical concentration. During her time at UTEP, she was part of many extracurricular activities, including Student Government Association, Medical Professional Organization and A-PRIME TIME, an accelerated medical program. Currently she sits on the committee for Adventure for your Future and SISD's Biomedical Advisory Board. Vianey is currently enrolled at the Johns Hopkins University Carey School of Business pursuing her master's degree in healthcare management.



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