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Astronomy

LEVEL ONE
GRADES 1-4

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WRITTEN BY BLAIR H. LEE, M.S.



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SAMPLE

REAL SCIENCE ODYSSEY

ASTRONOMY LEVEL ONE

PREVIEW

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This file contains a PDF preview of **RSO Astronomy (level one)**:

Introduction

What Is Astronomy?

Light Lab #1: Doing the Wave . . . Length

Light Lab #2: Meet Roy G. Biv

Light Lab #3: Mixing and Separating Light

Light Lab #4: The Highs and the Lows of Wavelengths

Light Lab #5: The Speed of Light

The Universe

Universe Lab #1: It Started with a Bang

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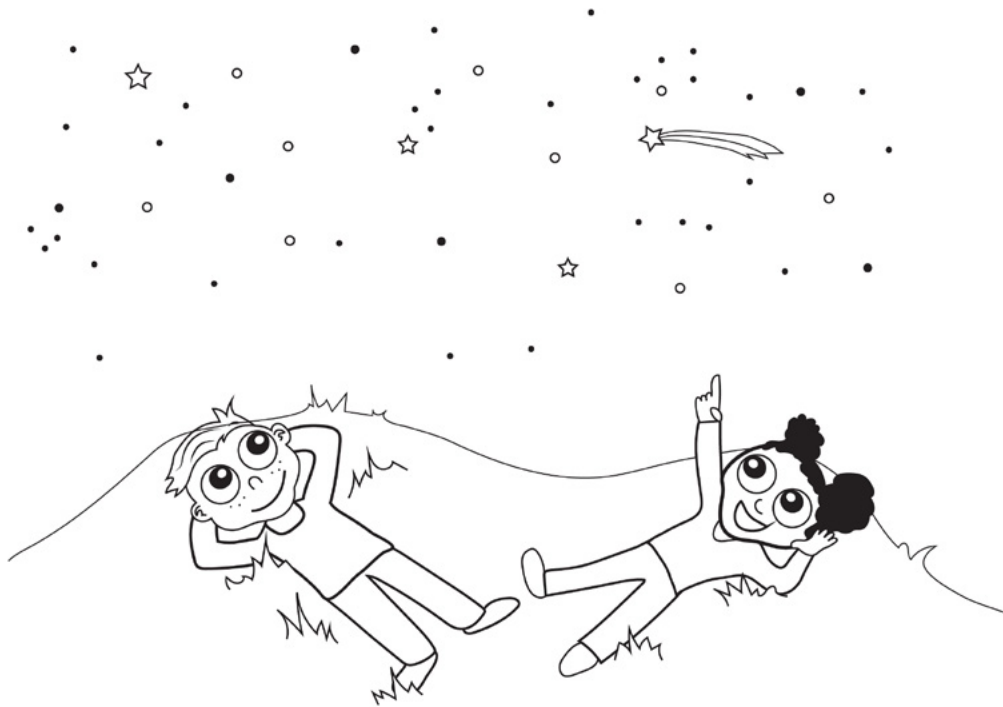
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Astronomy Level 1 for grades 1-4

Written by Blair Lee, MS
contributions by Terri Williams

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Written by Blair Lee, MS

Contributions and Illustrations by Terri Williams and Alina Bachmann

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About the Author



Blair H. Lee, M.S., is the founder of Secular Eclectic Academic (SEA) Homeschoolers, a supportive community that advocates for the exclusive use of secular academic materials. Blair is the primary author of Pandia Press's critically acclaimed REAL Science Odyssey (RSO) series, and she is the author of *The Science of Climate Change: A Hands-On Course*. She earned her Bachelor's degree in Biology and Chemistry and Master's degree in Chemistry at the University of California San Diego.

Blair is a passionate advocate of innovative academics using secular materials. Through her speaking and writing, her goal is to empower parents and teachers to dare to be innovative and create something unique and academically rich when handcrafting their student's journey through learning. When teaching at her local community college, Blair found that many of her students were lacking in basic

foundational science upon entering college. She believes science can be and should be taught from the beginning of a child's education. She began working with her own son and his friends on methods of teaching science concepts usually reserved for high school or college students. The results of her research and writing are RSO Chemistry, Biology, Astronomy, and Earth & Environment 1—concept-rich, hands-on courses that engage young people's minds and lay a firm foundation of science concepts.

Blair now spends her time writing science for young people. She lives in California with her husband, son, many dogs, and several guinea pigs. When not homeschooling her son and writing textbooks, she loves to ski, cook (most chemists are good cooks), read, and hike. You can contact Blair directly with questions about RSO and SEA Homeschoolers at blair@seahomeschoolers.com.

Science by Blair H. Lee, M.S.

The Science of Climate Change: A Hands-On Course

From Pandia Press:

The Stargazer's Notebook: A Yearlong Study of Night Sky

REAL Science Odyssey Chemistry level 1

REAL Science Odyssey Biology level 2

REAL Science Odyssey Astronomy level 1

REAL Science Odyssey Astronomy level 2

REAL Science Odyssey Earth & Environment level 1

REAL Science Odyssey Earth & Environment level 2 (coming 2019)

A Note from the Author

You may be wondering why Pandia Press is publishing another Astronomy course for 1st through 4th grade. *REAL Science Odyssey Earth & Space–Level 1* was originally published in 2005. There have been huge advances in our understanding of the universe since 2005. This course is about astronomy and incorporates a new thematic element woven throughout the course—scientific modeling.

Scientific modeling is the use of simplified representations to get a better understanding of a real system. Scientific models are an important tool scientists have long used, and many courses include them. This is generally done without explaining the modeling process. This course explains and focuses on modeling. In the labs and activities, students will practice the skill of developing and using simplified models to help them understand more complex systems. This approach leads to a more complete understanding of how scientists conduct science and of how science works.

I hope you enjoy the course,

Blair Lee

Introduction to Astronomy Level 1

This book is a complete, rigorous, and vocabulary-rich astronomy curriculum that needs no supplementation. It is not a collection of random labs with no flow from one to the other, nor is it an overwhelmingly long listing of trivial facts to be memorized and forgotten. This course was designed so that even the parent/teacher with little background in science could pick it up and teach science successfully with no need for further organizing or research. This course is the story of the universe.

This book is a minds-on and hands-on program. If you dislike hands-on learning and have no intention of getting gooey and dirty, RUN NOW! Science is about experimentation, and experimentation can be messy. This course has no fear. Are you still here? If so, roll up those sleeves and get ready to delve into the mystery of every star you spy in the sky.

This book was intended to be used from start to finish, much like a math book; as such, vocabulary and concepts build upon one another. You may encounter words and concepts that you feel the need to review and practice. Feel free to do that if you wish, but understand that vocabulary words are repeated throughout the course, so your students will hear the same words many times. This approach is intended to help them learn without having to drill. Having said that, review can be good. Anytime you can use a concept to refer to something you see in real life, your student will benefit greatly. Planning a peaceful evening? How about lying under the stars? Learn the names of the brightest objects you see. Look for meteors, airplanes, and satellites moving by. Use real words for what you see. Science is only a foreign language if it isn't used in real life.

For every notebook page in this book, children will do several lab activities that build upon and reinforce what they have heard. Labs also teach new material, so it is important to try to do all of the labs included. In addition, we have included book and website suggestions for a complete indoor and outdoor experience and further opportunity to dig into whatever your student finds most fascinating. You will notice that some of the labs are infused with age-appropriate math. Science is inherently mathematical with measuring, graphing, and calculating. If your student struggles with the math or with writing the results, don't let the lab papers overwhelm the lesson. The idea is to enjoy science. Much of the learning comes from doing and discussing. Read the questions to a pre-writing child and have them* dictate the answers back to you, or if you both find the questions tedious, skip them altogether.

Getting Started

1. Have fun. That's number one.
2. If you are a book person, pull out the book list and go over it a few weeks before you do any given section. Leave it in your library book bag or by your computer so you can check on the availability of the books you might want to check out.
3. If you are a nervous "Did I teach my student enough stuff" type of person, go over the What's the Big Idea? pages in this book. It will tell you what sorts of things your student should know by the end of the course. Use it with a grain of salt. Remember, the keys here are exposure and fun.
4. Look ahead to what material you will need for the upcoming week, or month if you're an über-planner (see page 18). All required materials are listed in the Lab Supply List (page 15) for easy reference. Be prepared. A few items may need to be ordered.
5. Read the For My Notebook lesson to yourself once so you know how to pronounce the new words in it. Curl up under that weeping willow or in front of the fire and read the lesson page to your students, even if they can read by themselves. Pause to do whatever it tells you to—stand up and move around, find a ball, and so forth. The notebook pages are written to the child and could be removed from the course and saved in their own notebook. The lessons are purposely short so they will spark curiosity without overwhelming with new vocabulary.
6. Follow the lab activities with a day of reading from the extra reading list or drawing. Drawing is an important skill for many scientists in the field or lab.
7. Did we mention you should have fun?

* Grammar note: This book uses singular 'they'.

The Unique Pages in this Book

For My Notebook Pages

1. All the student pages have a boxed outline around the material presented. That way it is easy to identify what is for the student and what is for the parent or teacher.
2. The For My Notebook (FMN) pages are the lesson pages that present the majority of new material to the student. They are intended to be read aloud. Students who are good readers may want to read the FMN pages aloud themselves to the parent or class. However orchestrated, these pages are intended to be read aloud and not silently, to encourage discussion and questions.
3. New science words are underlined. You will notice that many of the vocabulary words are not presented with a classic dictionary definition. Instead, the explanation is given in context, so it is “felt” rather than memorized. Formal definitions for the vocabulary words are offered in the Glossary at the back of the book.
4. If you wish, FMN pages can be removed along the perforated binding, three-hole punched, and then placed in a three-ring binder along with completed lab sheets to create an Astronomy Notebook.

Lab Sheets

1. The lab sheets are those pages that the student writes on. They also have a boxed outline because they are intended for the student, not the parent/teacher, to complete.
2. The lab sheets not only reinforce the material presented in the FMN pages, they also serve as the vehicle through which this course reinforces and formalizes scientific method. On the lab sheets, students will be making hypotheses based on questions formed during the lesson. Students record observations and lab results, and they make conclusions based on those results. They will also practice sketching details of their lab experiences, an important process that reinforces observation skills.
3. If you are working with a student who isn't writing yet, have them dictate the information to be written on the lab sheets. If your student is unable to draw (meaning physically incapable; I'm not referring to artistic abilities), then have them describe observations in detail for you to draw on the lab sheet.
4. If you wish, lab sheets can be removed along the perforated binding, three-hole punched, and then placed in a three-ring binder along with completed FMN pages.

The Instructor Pages

1. The instructor pages contain the supply lists for the labs or activities and procedure instructions.
2. These pages are written for the parent/teacher, but the procedure is often written as if for the student. For example, “Complete the hypothesis portion of the lab sheet,” is an instruction for the student, not the teacher.
3. Most instruction pages include a prompt to read aloud to students. A great deal of course instruction and new science vocabulary are found in these prompts. If you dislike prompts, then be sure to present the information in your own words.

What's the Big Idea?

Whenever you study a subject, there are main ideas and details to learn. It's true that there is a lot of new material to discover in science. This outline gives you the big ideas that your student should get from each unit, and the small stuff that is an added bonus. If you and your student are timid scientists, just have fun as you try to learn the big ideas. If you and your student have a strong science background, work on learning the small stuff as well as the big ideas. There are many challenging words in this course that are used because they are the right words. After they are heard over and over, they will "sink in." Your student does not need to memorize them the first time around. Use difficult words and science concepts gently, not with force, and your student will enjoy the science experience.

BI = BIG IDEA

SS = SMALL STUFF

LIGHT

BI = Light travels through space in waves.

Scientists use the properties of light to learn about the universe.

SS = Light waves come in a range of wavelengths.

Waves have amplitude.

Waves travel in a vacuum at a constant rate called light speed.

The wavelengths of light can be separated.

White light is a combination of all light wavelengths.

The different wavelengths in white light arranged from the longest to the shortest create the pattern ROYGBIV (red, orange, yellow, green, blue, indigo, violet).

THE UNIVERSE

BI = The universe is 13.82 billion years old. Scientists use a scientific model called the Big Bang Model to explain how the universe started.

Stars are made of a state of matter called plasma.

Plasma is similar to gas, but different because it is made of charged particles like those that make static electricity.

When we look at stars in the sky, we call the patterns they form constellations.

Besides planets, moons, and stars, there are also rocks of various sizes out in space.

The North Pole points to Polaris (the North Star).

You can find Polaris by finding the Big Dipper and following the two pointer stars up.

The North Star is always in the same part of the sky. All of the other stars appear to move through the sky at night.

Scientific models help us understand complicated ideas about the world by simplifying some parts of those ideas.

SS = The three types of scientific models are visual models, computer models, and mathematical models.

The universe started as pure energy.

The universe has changed during its 13.82 billion-year lifetime.

Ancient people named the patterns in the stars after their gods, goddesses, and mythical beasts.

If you lived at the North Pole, Polaris would be directly overhead. You can tell how far away from the North Pole you are by how close to the horizon Polaris is.

THE SOLAR SYSTEM

BI = The sun is a star.

Gravity is the force that keeps the planets orbiting the sun and moons orbiting planets. The larger an object is the larger its gravity is.

Our solar system has eight planets.

The planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

The closer a planet is to the sun, the warmer it is on that planet.

SS = It is daytime on the side of the planet facing the sun and generally warmer than the side of the planet facing away from the sun where it is nighttime.

Each planet has unique characteristics.

EARTH

BI = Planets like Earth that are not too far or too close to a star for liquid water to exist are in the Goldilocks zone because they are neither too hot nor too cold.

Life evolved on Earth over 3.8 billion years ago. Scientists think Earth's location in the Goldilocks zone to be an important factor to the initial and continued evolution of life on Earth.

Earth is the 3rd planet from the sun.

SS = The sky on Earth is blue because the types of molecules in Earth's atmosphere scatter the shorter blue wavelengths more than the other colors.

Particles in Earth's atmosphere also make the planet just right for life to thrive and evolve.

SPACE TRAVEL

BI = Astronauts use rockets to travel to space.

There is an attractive force called gravity that rockets must counteract in order to leave Earth.

When conducting science labs, you are often asked to form a hypothesis, record observations, and make a conclusion.

A hypothesis is a statement about what you think will happen during the experiment and why you think it will happen.

Observations are those things you observe occurring while conducting an experiment.

A conclusion is based on observations.

SS = Rockets are made in stages. The stages contain fuel. Once the fuel is used up, the stage drops off the rocket.

The force rockets use to counteract Earth's gravity comes from pushing the gas from burning rocket fuel out of the rear of the rocket.

MOON

BI = A rotation is one complete spin on an axis. We call that one day.

A revolution is one trip around another body (like the sun). One full circle around the sun is one year.

The same side of the moon always faces Earth.

The moon and Earth each spin in place, and they each travel around another body.

The moon orbits around Earth. Each night the moon appears to change shape because the side we see is not always the side the sun is shining on.

SS = The major moon phases are called full, gibbous, quarter, crescent, and new.

It takes about 28 days for the moon to complete one full cycle (from full moon to full moon or from new moon to new moon).

VENUS

BI = Venus is the 2nd planet from the sun.

It is the hottest planet in the solar system because of the composition of its atmosphere.

When a meteorite hits a planet (or other body) it can make a crater.

SS = Venus rotates in the opposite direction of Earth and most of the other planets because it was struck by a very large object in the distant past that affected its rotation.

Moons can form from debris thrown into space after a planet is struck by a large object.

On November 3, 1973, Mariner 10 lifted-off from Cape Canaveral, Florida.

Mariner 10 used a gravity assist from Venus to change its speed and direction to help Mariner 10 on its way to Mercury and the sun.

MERCURY

BI = Mercury is the planet closest to the sun.

Scientists build spaceships to withstand the extreme conditions found in space.

The force of gravity is affected by mass and distance.

SS = Mercury is hot during its daytime and cold at night.

Heat transfer occurs through radiation, conduction, and convection.

Scientists must account for heat transfer to protect sensitive equipment in space ships.

The force of gravity is so much greater for the sun versus Mercury that Mariner 10 orbited the sun and did flybys of Mercury when observing Mercury.

VOYAGER 2

BI = Space probes are spaceships that do not orbit Earth. They travel through space and collect information that is sent back to scientists on Earth. Space probes do not have astronauts in them.

SS = The timing for the launch of Voyagers 1 & 2 was chosen because of the alignment of the planets Jupiter, Saturn, Uranus, and Neptune.

Voyagers 1 and Voyager 2 left Earth with many different types of scientific instruments.

MARS

BI = Mars is the 4th planet from the sun.

A rover is a space vehicle that moves across a planet's surface collecting information.

SS = Mars is red because its surface is covered with rust.

The rover Curiosity roams around the surface of Mars equipped with scientific instruments that monitor and record conditions on the planet. The information it collects is sent back to scientists on Earth.

Curiosity landed on Mars on August 5, 2012.

Mars is in the Goldilocks' Zone.

No life has been found on Mars to date.

Mars has frozen water at its Poles.

ASTEROID BELT

BI = There is a large ring of asteroids between Mars and Jupiter.

Asteroids are a type of meteoroid that orbits the sun.

Meteoroids have different names depending on where they are and what they orbit.

SS = The asteroid belt takes up so much space that most of the asteroid belt is empty space.

Asteroids are made of rock, dust, and ice.

Meteoroids are rocks out in space. When these rocks hit the atmosphere and burn up they are called meteors. When they crash into Earth they are called meteorites.

A meteoroid that struck Earth 65 million years ago most likely led to the extinction of dinosaurs.

The frost line, which is located in the asteroid belt, is the point where the temperature in the solar system drops low enough for molecules that normally form gases on Earth to form solid ice grains.

JUPITER

BI = Jupiter is the 5th planet from the sun.

Jupiter is the most massive planet in the solar system and because of this Jupiter has a larger force of gravity than any planet. The only object in the solar system with a larger force of gravity is the sun, because the sun is more massive than Jupiter.

SS = Jupiter has 69 moons because of its large force of gravity.

Jupiter has huge storms that have been raging for years.

Jupiter, Saturn, Uranus, and Neptune are referred to as the outer planets. Jupiter and Saturn are known as gas giants. Uranus and Neptune are known as ice giants because of frozen gases.

Jupiter's moon Io has active volcanoes.

SATURN

BI = Saturn is the 6th planet from the sun.

The rings of Saturn can be used to model a solar system before the dust, ice, and rocks come together to form planets.

SS = Planets form when rocks, ice, and dust come together under the force of gravity.

URANUS

BI = Uranus is the 7th planet from the sun.

Uranus is tilted on its side and, like Venus, rotates in the opposite direction of the other planets. Scientists think this is evidence that it was struck multiple times by large objects.

SS = Because of its extreme tilt, Uranus has four seasons, but each one is 21 years long.

Uranus and Neptune are aqua in color because of the molecules in their atmosphere.

NEPTUNE

BI = Neptune is the 8th planet from the sun.

SS= Neptune is closer to the sun than Pluto for 228 years of its orbit, and it is farther from the sun for 20 years of its orbit.

Neptune is the windiest planet.

Daylight on Neptune is like dusk on Earth because so little sunlight reaches it.

KUIPER BELT AND OORT CLOUD

BI = The Kuiper Belt is an area of the solar system beyond Neptune containing thousands of objects. Pluto is in the Kuiper Belt.

The Oort cloud is the area that is the boundary between the solar system and the rest of space.

Comets form in the outer reaches of the solar system in the Kuiper belt and the Oort Cloud.

SS = Pluto, a dwarf planet, is farther away from the sun than any of the planets except Neptune for 20 years of its orbit.

Comets are made of ice, rocks, and dust. Comets crashing into Earth are one of the sources of water in the hydrosphere.

A planet is classified as such based on its shape and whether it has cleared the path of its orbit.

Voyagers 1 and 2 are in the outer reaches of the solar system. Voyager 1 might have even left it.

There are probes in many parts of the solar system from countries all over the world.

The planets have characteristic colors based on the molecules in their atmosphere.

Lab Supply List

Items are listed in alphabetical order. The amounts listed are totals for the entire course. If no amount is indicated then the number needed is 1. Most items are common household items.

* Means the item requires some explanation. Ordering hints and explanations are given on page 17.

EQUIPMENT / MATERIAL	AMOUNT/SIZE
Alarm clock or phone app	
Aluminum foil	1 roll
Ammonia	¼ teaspoon
Baking soda	2 tablespoons
Bar magnets	2 identical
Binoculars* or telescope (optional)	
Blow dryer	
Bowls– large & small	1 each
Butter	1 stick
Calculator (optional)	
Candies– small (optional)	1 bag
Cardboard boxes	1 medium-size, 1 jewelry box-size, 2 long and narrow
Cardstock (white and colored)	4 sheets of white (optional) 11 sheets colored
Cellophane (red, green, blue, and yellow)	1 large sheet of each
Chalk– sidewalk	
Chocolate candies– round, individually wrapped (Rolos or mini Reese's Peanut Butter Cups)	1 bag
Clear dish washing liquid (colorless)	1 bottle
Clipboard	
Coffee cans full of rocks or other heavy items	2
Color photo of Jupiter (optional)	

EQUIPMENT / MATERIAL	AMOUNT/SIZE
Colored pencils, crayons, or markers	
Compact disc, plain with no labeling or graphics	
Compass (directional)	
Computer w/ Internet (optional)	
Construction paper 12' × 18'	1 pack
Cork	
Corn syrup, molasses, agave syrup, or maple syrup	½ teaspoon
Cotton ball	
Desk lamp (with a flexible neck)	
Dictionary, encyclopedia, or online search	
Drinking glass	2 large
Drinking straws	3
Dry erase marker	
Dry ice*	2 cups
Duct tape	1 roll
Flashlights	4
Flour	1 cup
Flour sifter or fine mesh strainer	3
Food coloring - red and yellow	1 bottle each
Funnel	
Glass casserole dish	
Glass containers	2 identical
Globe	

SAMPLE

EQUIPMENT / MATERIAL	AMOUNT/SIZE
Glue	1 bottle
<i>Goldilocks and the Three Bears</i> story	
Graham crackers	1 box
Hammer	
Inflatable globe*	
Instant chocolate milk powder or hot cocoa powder	¼ cup
Jello	1 box
Long, thermally insulated gloves	
Marble - large	1
Measuring tape	
Metal hanger or wire	1
Metal pan	
Metal shavings	1 small container
Mini marshmallows	1 bag
Mixing spoon	
Moon phases chart	
Newspaper (optional)	
Nonfat milk	¼ teaspoon
One-gallon baggies– the thick kind	2
Oven mitts	
Packaging peanuts, wads of paper, or something else to stuff in container	
Paper towels	1 roll
Pencils	
Plastic eggs	2
Plastic storage containers, one small and one very small	2
Plastic wrap	1 roll

EQUIPMENT / MATERIAL	AMOUNT/SIZE
Plate	
Pretzel sticks	1 bag
Refrigerator	
Rubber bands - large	1 pack
Rubber gloves	
Ruler, metric	
Sand or dirt	¼ cup
Safety goggles	
Scissors	
Screw, bolt, or nail	1
Sharp tool to puncture the tennis ball	
Shiny wrapping paper	1 roll
Shoebox	
Sidewalk or blacktop area	
Skewer	
Soda bottle - 2-liter plastic	
Solar system stickers, trims, decorations (optional)	
Stapler	
Star chart or planisphere for your location	
Stargazing optional items - lounge chair, blanket, thermos of hot cocoa	
Steel wool	
Stopwatch	
String	about 6 meters
Styrofoam cooler - small	
Sunny day	
Table	
Table lamp	

EQUIPMENT / MATERIAL	AMOUNT/SIZE
Tape	
Tennis balls	2
Thermometers* (weather and science type)	1 of each
Timer	
Toilet paper rolls (empty)	4
Tongs	
Toothpicks	1 box
Trash bag– thick, yard type	
Tube of cake icing	
Un-sharpened pencils	3
Vinegar	2 cups
Wall space	
Water	
Well-ventilated room	
White paper	1 pack
Whole milk or half and half cream	1 cup
Wrapping paper roll (empty)	

*Ordering Hints and Explanations:

1. Thermometers: Science and weather thermometers rise and fall automatically, unlike medical thermometers which must be shaken down. A kitchen thermometer will most likely work in place of a science thermometer. A weather thermometer has a greater range of temperatures (i.e. below 0°C) than a kitchen thermometer and offers degrees in both Fahrenheit and Celsius, all on a handy support base.
2. Inflatable Globe: It gets tossed around so a regular globe won't work. The easiest place to find an inflatable globe is online. In a pinch, a beach ball or other light ball can be used as a substitute.
3. Binoculars: 7 × 35 is a nice choice to get. I would avoid the \$10 ones, but you don't have to spend \$100. Binoculars are optional, but give a view of the moon that can only be beat with a telescope.
4. Dry Ice: Dry ice will burn unprotected skin and can produce toxic levels of carbon dioxide! Before purchasing dry ice, carefully read Safety Information Concerning Dry Ice Storage, Usage, and Disposal found on page 236 . Many grocery, big-box, and hardware stores offer dry ice. Dry ice has a short shelf life (about 24 hours for 5 pounds), so purchase just before use.

Suggested Weekly Schedule

The following schedule is suggested for those wishing to complete this course in 18 weeks, teaching science twice a week. General supplies needed for each week are listed. Refer to the lesson or supply list for specifics on supplies including quantities.

Week	Day	Lesson / Lab	Supplies Needed for the Week	Dates / Notes
1	Day 1	WHAT IS ASTRONOMY? Light Lab #1: Doing the Wave . . . Length	Large rubber band, Shoebox, Pencils, Flashlights (4), Cellophane (red, green, blue, and yellow), Tape, Compact disc, Colored pencils, White surface	
	Day 2	Light Lab #2: Meet Roy G. Biv Light Lab #3: Mixing and Separating Light		
2	Day 1	Light Lab #4: The Highs and the Lows of Wavelengths Light Lab #5: The Speed of Light	Stopwatch, Flashlight, Extra people, Colored Pencils, Scissors, Glue or tape, Large sheet of construction paper	
	Day 2	THE UNIVERSE Universe Lab #1: It Started with a Bang		
3	Day 1	Universe Lab #2: How Far Is a Light-Year? Universe Lab #3: Constellation/Asterism Dot-to-Dot	Screw (or bolt or nail), Metric ruler, Tape measure, Another person, Clipboard, Binoculars or telescope (optional), Compass (directional), Flashlight, Red cellophane, Rubber band, Globe, Star chart for your location, Other optional items: lounge chair, blanket, thermos of hot cocoa	
	Day 2	Universe Lab #4: Finding the North Star Universe Lab #5: Be a Night Sky Detective		
4	Day 1	THE SUN IS THE CENTER OF THE SOLAR SYSTEM Solar System Lab #1: Suns, Planets, Moons	Large sheet of drawing paper, Colored pencils, Thermometer (weather), Alarm clock or phone app, Plate, Sunny day	
	Day 2	Solar System Lab #2: The Sun Heats Things Up		
5	Day 1	Solar System Lab #3: Solar System Poem Solar System Lab #4: Solar System Book	Colored pencils, Large drawing sheet, Colored cardstock, Glue, Solar system decorations, Stapler, Scissors, <i>Goldilocks and the Three Bears</i> book	
	Day 2	EARTH: THE GOLDSILLOCKS PLANET Earth Lab #1: The Goldilocks Planet		
6	Day 1	Earth Lab #2: Why Is the Sky Blue? Earth Summary	Colored pencils, Drinking glasses, Water, Flashlight, Nonfat milk, Scissors, Glue (optional), White cardstock (optional)	
	Day 2	AND NOW A MESSAGE FROM A SPACE-DUST BUNNY Rocket Lab #1: My Rocket Ship		
7	Day 1	Rocket Lab #2: 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, BLASTOFF!	2-liter plastic soda bottle, Un-sharpened pencils, Duct tape, Cork, Paper towel, Baking soda, Vinegar, Funnel, Scissors, Inflatable globe, Small ball, Dry erase marker, Table lamp, Extra people, Moon phases chart, Colored pencils, Binoculars (optional)	
	Day 2	THE MOON HAS A DARK SIDE Moon Lab #1: The Moon Runs Circles Around Us Moon Lab #2: My Moon Phases Chart (start)		
8	Day 1	FIRST STOP: VENUS Venus Lab #1: Modeling a Gravity Assist	Extra people, Large area, Tennis ball, Level area, Metal pan, Flour, Instant chocolate milk powder, Flour sifter, Newspaper (optional), Large marble, Metric ruler, Long tweezers or tongs	
	Day 2	Venus Lab #2: Venus: A Greater Crater Venus Summary		

9	Day 1	MERCURY: CLOSEST PLANET TO THE SUN Mercury Lab #1: Too Close for Comfort	Table, Electrical outlet, Metric ruler, Lamp with a flexible neck, Thermometer, Cardboard box, Plastic eggs, Butter, Blow dryer, Duct tape, Scissors, Oven mitt, Packaging peanuts, Toothpicks, Scotch tape, Plastic wrap	
	Day 2	Mercury Lab #2: Heat: Challenge of Space Travel		
10	Day 1	Mercury Summary A VOYAGE ON VOYAGER	Cardstock, Empty toilet paper rolls (4), Empty wrapping paper roll, Plastic storage containers, Drinking straws, Aluminum foil, Shiny wrapping paper, Long narrow cardboard boxes, Jewelry box-size box, Glue, Scissors, Tape, Cotton ball, Ruler	
	Day 2	Voyager Lab: Build the Ship		
11	Day 1	MARS: THE FOURTH PLANET FROM THE SUN Mars Lab #1: Eating My Curiosity	Individually wrapped round chocolate candies (Rolos or mini Reese's Peanut Butter Cups), Tube of cake icing, Toothpicks, Pretzel sticks, Graham crackers, Plastic straw, Mini marshmallows, Small candies (optional), Steel wool, Dish soap, Small bowl, Water, Rubber gloves, Crayons	
	Day 2	Mars Lab #2: The Red Planet Mars Summary		
12	Day 1	TRAVELING THROUGH THE ASTEROID BELT Asteroid Belt Lab #1: Asteroids Come from the Asteroid Belt	Colored pencils, Box of jello, Water, Measuring cup, Glass containers, Thermometer, Timer, Refrigerator, Calculator (optional), Computer (optional)	
	Day 2	Asteroid Belt Lab #2: Jiggling at the Frost Line		
13	Day 1	JUPITER: IT'S GIGANTIC! Jupiter Lab #1: Jupiter Has the Moons	Metal hanger or wire, Glass bowl or pie plate, Whole milk, Red and yellow food coloring, Dish washing liquid (colorless), Colored pencils, Color photo of Jupiter	
	Day 2	Jupiter Lab #2: Jupiter's Big Storm Jupiter Summary		
14	Day 1	RINGING SATURN: THE SIXTH PLANET Saturn Lab: A Mini Solar System	Bar magnets, Metal shavings, Ruler, Glass casserole dish, White paper, Extra person	
	Day 2	Saturn Summary		
15	Day 1	URANUS: AQUA BULLS-EYE OF THE SOLAR SYSTEM Uranus Lab: The Sideways Planet	Skewer, Tennis ball, Large bowl, Magic marker, Something sharp to puncture the tennis ball, Colored pencils (optional)	
	Day 2	Uranus Summary		
16	Day 1	LAST STOP: NEPTUNE THE EIGHTH PLANET Neptune Lab: Neptune Is Out of Order	Coffee cans (2) full of rocks or other heavy items, String, Ruler, Scissors, Sidewalk chalk, Colored pencils, Sidewalk or blacktop area	
	Day 2	Neptune Summary		
17	Day 1	BEYOND NEPTUNE: VOYAGING THROUGH SPACE Beyond Neptune Lab #1: Define Planet	Internet access, Colored pencils, Dry ice, Sand or dirt, Ammonia, Corn syrup, Styrofoam cooler, Trash bag—yard type, One-gallon baggies, Hammer, Oven mitts or long thermally insulated gloves, Mixing spoon, Well-ventilated area, Lamp and a dark room (well-ventilated), Outside area	See page 236 for safe handling of dry ice.
	Day 2	Beyond Neptune Lab #2: Where Comets Come From		
18	Day 1	Travel Map of the Solar System	Colored pencils, Construction paper, Glue, Tape, Decorations for Solar System book	
	Day 2	Solar System Book—complete, decorate, and study		

Further Reading and Exploring

EXCELLENT RESOURCES FOR GENERAL SCIENCE AND ASTRONOMY

The Usborne First Encyclopedia of Space – Paul Dowswell
The Kingfisher Science Encyclopedia
The Usborne Internet-linked Science Encyclopedia
The Usborne Illustrated Dictionary of Science
The Earth and Sky (Scholastic: A First Discovery Book) – Gilliamard Jeunesse
How The Universe Works (Reader's Digest) – Heather Couper and Nigel Henbest
The Reader's Digest Children's Atlas of the Universe – Robert Burnham
Usborne Book of Astronomy and Space – Lisa Miles
The Night Sky (Usborne Spotter's Guide) – Nigel Henbest and Stuart Atkinson
The Kingfisher Young People's Book of Space – Martin Redfern

LIGHT

What Are Light Waves? – Robin Johnson
Light and Its Effects – Jenna Winterberg
The Magic School Bus: The Mysteries of Rainbows – The Young Scientists Club
All the Colors of the Rainbow – Allan Fowler
Light: Shadows, Mirrors, and Rainbows – Natalie M. Rosinsky
All About Light – Lisa Trumbauer
What Are Sound Waves? – Robin Johnson
Sound Waves and Communication – Jenna Winterberg
Sounds All Around – Wendy Pfeffer

UNIVERSE AND SOLAR SYSTEM

The Magic School Bus Sees Stars – Joanna Cole
The Earth and Sky (Scholastic- A First Discovery Book) – Gallimard Jeunesse and Jean-Pierre Verdet
Stargazers – Gail Gibbons
Stars: A New Way to See Them – H.A. Rey
Stars: A Guide to the Constellations, Sun, Moon, Planets, and Other Features of the Heavens – Herbert Spencer Zim
Find the Constellations – H. A. Rey
Stars – Seymour Simon
Galaxies – Seymour Simon
Night Sky (Eyewitness Explorer) – Carole Stott
The Night Sky (One Small Square series) – Donald M. Silver
Which Way to the Milky Way? – Sidney Rosen
The Universe – Seymour Simon (Nebulas, black holes and other distant space objects)
Comets, Meteors and Asteroids – Seymour Simon
Many other titles by Seymour Simon: *The Sun, Mercury, Venus, Mars, Destination Mars, Jupiter, Destination Jupiter, Saturn, Uranus, Neptune, Planets, Around the Sun, Our Solar System*
Professor Astro Cat's Frontiers of Space – Dr. Dominic Walliman and Ben Newman
Information Graphics: Space – Simon Rogers

Older than the Stars – Karen C. Fox

The Story of Space: A First Book about our Universe – Catherine Barr, Steve Williams, and Amy Husband

Glow in the Dark: Voyage through Space – Katy Flint and Cornelia Li

DK Eyewitness Books: Universe

The Stargazer's Notebook – Blair Lee

You Are Stardust – Elin Kelsey

What's Out There: A Book about Space – Lynn Wilson

Gravity Is a Mystery – Franklyn M Branley

The Moon Seems to Change – Franklyn M. Branley

What the Moon Is Like – Franklyn Branley

The Moon Book – Gail Gibbons

Next Time You See the Sunset – Emily Morgan

The Magic School Bus Lost in the Solar System – Joanna Cole

The Planets – Gail Gibbons

The Planets in Our Solar System – Franklyn M. Branley

Roaring Rockets – Tony Mitton

Next Time You See the Moon – Emily Morgan

Postcards From Pluto: A Tour of the Solar System – Loreen Leedy

Learning About the Solar System (Dover Little Activity Books) – Bruce Lafontaine

Glow in the Dark Constellations: A Field Guide for Young Stargazers – C.E. Thompson

The Sky Observer's Guide (A Golden Guide) – R. Newton Mayall

SPACE TRAVEL

Exploring Space: From Galileo to the Mars Rover and Beyond - Martin Jenkins and Stephen Biesty

Space Machines - Ian Graham, Charles Ballesteros, and Martin Taylor

Amazing Machines Roaring Rockets Activity Book - Tony Mitton

Margaret and the Moon - Dean Robbins

Movies and Television Featuring Voyager and Space Exploration

Space: 1999 episode "Voyager's Return"

Star Trek: The Motion Picture (1979)

Star Trek V: The Final Frontier (1989)

Starman (Features encounters with Voyager 2 and the Golden Record.)

2012 anime, *Humanity Has Declined*, "Episode 6: The Fairies Homecoming (Part 2)"

1994 *X-Files* episode "Little Green Man"

PBS documentary: "The Farthest—Voyager in Space"

Web Suggestions

The site WatchKnowLearn.org is a great site. At no cost to you, it catalogues links to videos by topic and grade.

LIGHT

This video covers some topics that were not covered in the chapter:

<http://studyjams.scholastic.com/studyjams/jams/science/energy-light-sound/light.htm>

UNIVERSE AND SOLAR SYSTEM

Outer space definitions: www.kidsastronomy.com/deep_space.htm

The Big Bang explained: https://www.esa.int/esaKIDSen/SEMSZ5WJD1E_OurUniverse_0.html

NASA Kids: <https://www.nasa.gov/kidsclub/index.html>

NASA for K-4 educators: <https://www.nasa.gov/audience/foreducators/k-4/index.html>

Crash Course Astronomy Videos: <https://thecrashcourse.com/courses/astronomy?page=2>

Answers to moon questions: teacher.scholastic.com/researchtools/articlearchives/space/moon.htm

Awesome moon phases: www.niehs.nih.gov/kids/lunar/home.htm

Excellent solar system site: kids.nineplanets.org/intro.htm

Great pictures of the planets: pds.jpl.nasa.gov/planets

Your age on other planets: www.exploratorium.org/ronh/age/index.html

Solar system updates: solarsystem.nasa.gov/planets/index.cfm

Learn about our solar system: www.kidsastronomy.com/solar_system.htm

Offers a really good perspective on relative sizes and distances of everything from atoms up to galaxies. <http://scaleofuniverse.com/>

Space Travel

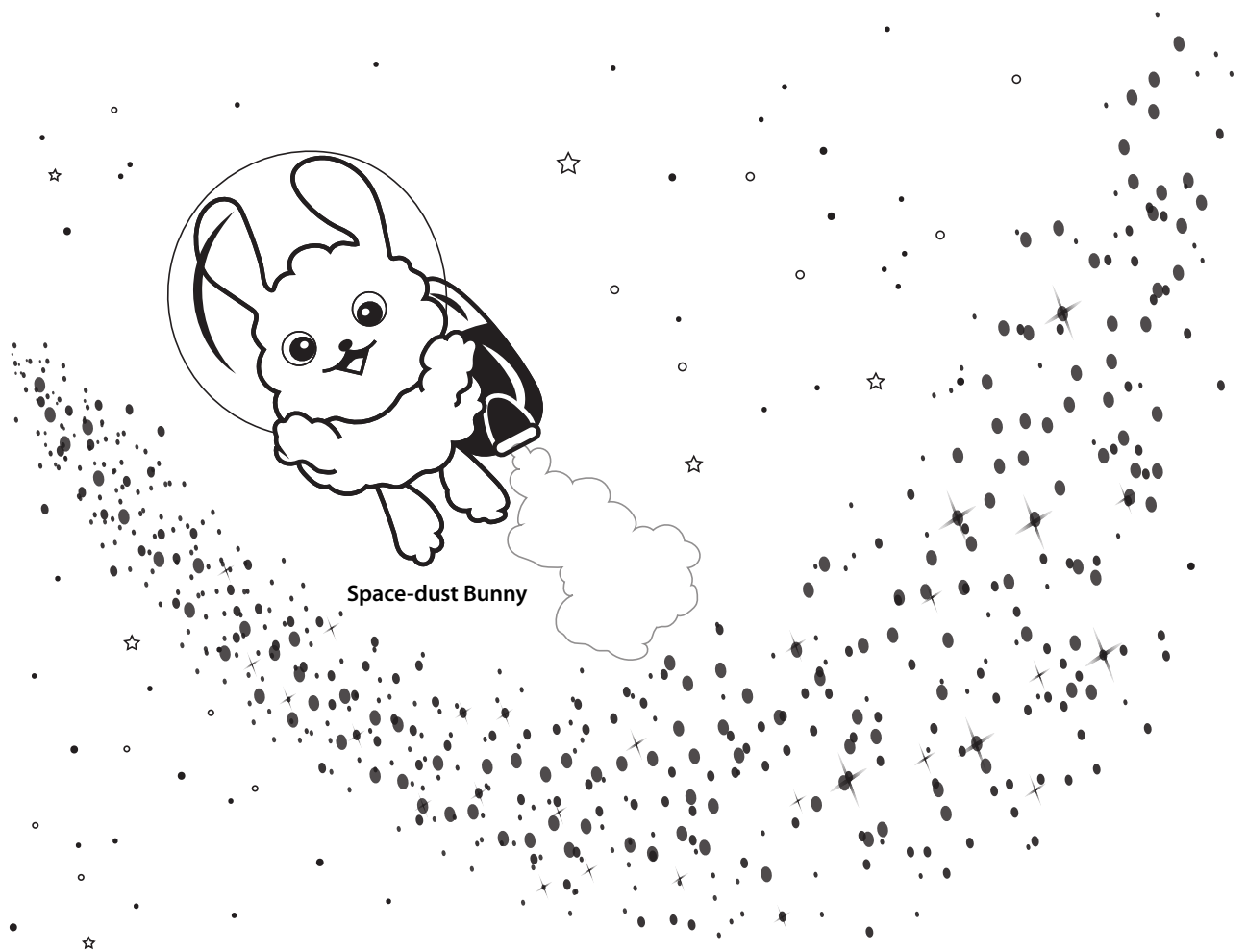
"The First Spacecraft to Use Gravity Assist," a short video about Mariner 10:

<https://airandspace.si.edu/stories/objects/first-spacecraft-use-gravity-assist>

"Planets Aligned," a short video about Voyager:

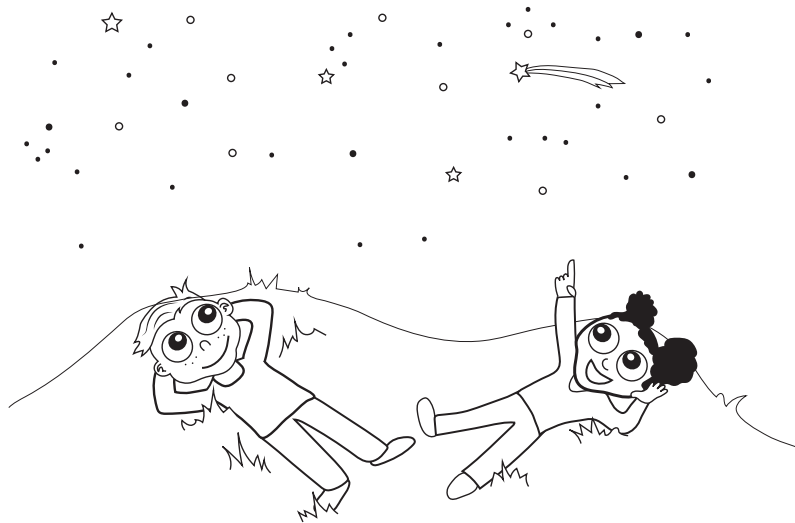
<https://airandspace.si.edu/stories/objects/voyager-planets-aligned>

Astronomy



For my notebook

WHAT IS ASTRONOMY?



Have you ever sat outside at night and looked up at the stars dreaming of traveling into space, seeing other planets, and meeting aliens? If you have then you have dreamed about studying astronomy.

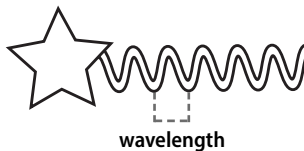
When you look up at the sky what do you see? (Never look directly at the sun as it can damage your eyes.) A lot of blue and possibly some clouds? What would you see if you looked up at night? Stars, the moon, and other planets, right? Stars look like tiny, white lights in space, but what are they really? A star is a huge ball of hot, glowing plasma. Plasma is similar to gas, but different because it is made of charged particles like those that make static electricity. The closest star to us is our very own sun. That's right, our sun is a star. Many of the other stars in space have planets moving around them, just like our sun.

Astronomers study space and everything within it, including Earth. Things in space are very far apart from each other. Have you ever wondered how astronomers study distant stars and planets? What comes to Earth from the stars? What is it about stars that make it so you can see them at night? Did you answer light? Astronomers use the properties of light to study space and everything in it.

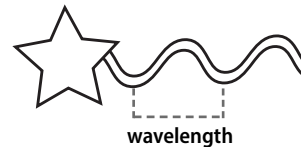
For my notebook - page 2

Are you are wondering how light can have properties? Think about it, at night when the sun isn't shining on the side of Earth where you live, it is dark outside. During the day, when the sun is shining where you live it is light outside. Energy waves traveling from the sun create light. Energy waves that make light come from all stars. It is one of the things that makes a star a star. These energy waves can come in different lengths and at different heights. These are two of the properties of light.

Waves come in different lengths. The length of a wave is called its wavelength. Hotter stars emit shorter wavelengths than cooler stars.



**This hot star is emitting
a short wavelength.**

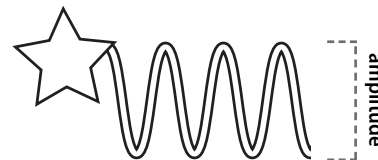


**This cooler star is emitting
a longer wavelength.**

Waves come in different heights. The height of a wave is called its amplitude. The more energy coming from a star, the higher the amplitude is of the waves coming from it.



This star is emitting energy.



This star is emitting more energy.

Using these two properties of light, astronomers are able to determine what planets and stars are made of. The properties of light can also be used to learn more about the age of objects in space and even of space itself. In the next labs, you will investigate some of the properties of light astronomers use. You will learn about the color of light waves (yes, they have a color!), the height of waves, and the speed of light waves (they are REALLY fast). First though, let's learn more about wavelength.

Light Lab #1: Doing the Wave . . . Length–Instructions

Materials

- Lab sheet, pencil
- Large rubber band
- Box (one that the rubber band fits comfortably around but fairly snug). A shoebox works well.
- 2 pencils

Aloud: Have you ever been to a beach and watched the waves? Waves can be big or small. There can be a lot of distance or a little distance between the top of one wave and the top of the next. Some waves come crashing into the shore and other waves gently roll up onto the beach. Light energy, like the energy that travels to Earth from the sun, is carried in the form of waves. Ocean waves also carry the energy of motion, which is a different sort of energy than is carried by light.

You do not need to go to the beach to see waves. All you have to do is turn on a light switch. You can think of light as a wave, just like astronomers do when they study space. Light is described by certain properties that astronomers use to learn more about the size and distance of stars and galaxies. Light waves can be hard to study. Luckily, just like there are light waves, there are sound waves. You cannot see sound waves, but you can hear them.

Right now, stop and make a high-pitched squeaky noise. Now make a low-pitched noise. The sounds you made were different because the length of the sounds waves was different. The high-pitched squeaky noise came from short wavelengths. The low-pitched noise came from longer wavelengths. In this lab, you will experiment and see how changing the length of sound waves changes the sound you hear. Then in the next lab, you will experiment and see how changing the length of light waves changes the colors of the light you see.

Procedure

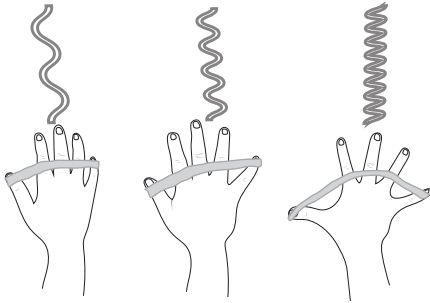
1. Put the rubber band between your thumb and pinky finger. Stretch the rubber band so it just starts to feel tight around your fingers. Looking down at your fingers, pluck the rubber band. You should see the rubber band vibrate back and forth. Stretch your fingers farther apart. Pluck the rubber band again. Stretch your fingers as far apart as they will go. Now pluck the rubber band one last time. Complete #1 on your lab sheet.
2. Put the rubber band snugly around a solid side of the box. Put the two pencils about two inches apart under the rubber band. Pluck the rubber band. Listen to the sound it makes. Continue plucking the rubber band (or have someone do it for you) as you look at the vibration of the rubber band from above it and from the side.
3. Move the pencils farther apart. They will still be under the rubber band. Pluck the rubber band. Listen to the sound it makes. Continue plucking the rubber band (or have someone do it for you) as you look at the vibration of the rubber band from above it and from the side.
4. Move the pencils until they are at the two outside edges on the top of the box. They will still be under the rubber band. Pluck the rubber band. Listen to the sound it makes. Continue plucking the rubber band (or have someone do it for you) as you look at the vibration of the rubber band from above it and from the side.
5. Answer the rest of the questions on the lab sheet.

[continued]

Answers

#1. The wavelength got shorter the farther apart my fingers were.

Drawings should show the rubber band being stretched and the wavelengths decreasing in length (increasing in frequency and pitch) as the fingers are stretched farther apart.



#2. Yes, you can hear a difference. Differences could be described as, "shorter sound waves have a higher pitch than longer ones." Students could also draw the wavelengths getting progressively shorter as the frequency (pitch) gets higher.

More Lab Fun

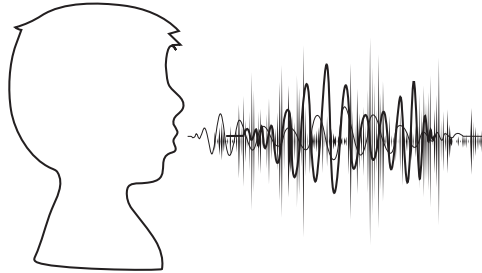
- Add more pencils or try them at different length.
- If a stringed instrument is available, investigate what creates different sounds from the strings of the instrument.

Instructor's Notes

- The purpose of this activity is to show that waves can occur at different lengths and that the change in wavelength can change observable properties.
- If you play a stringed instrument or piano you will be familiar with the change in tone as a change in pitch or frequency.

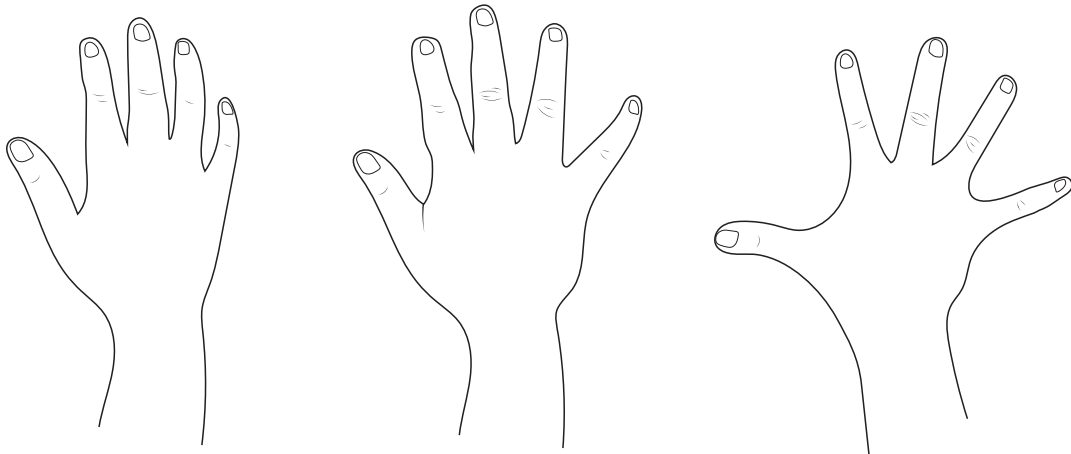
NAME _____ DATE _____

DOING THE WAVELENGTH



1. If you think of the vibrations you observed as waves, how did the length of the wave change as your fingers moved farther apart?

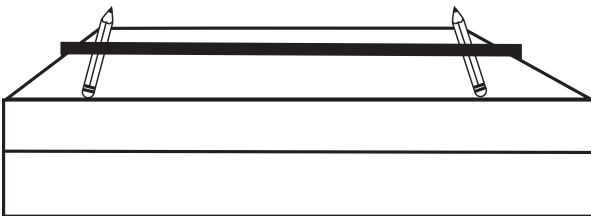
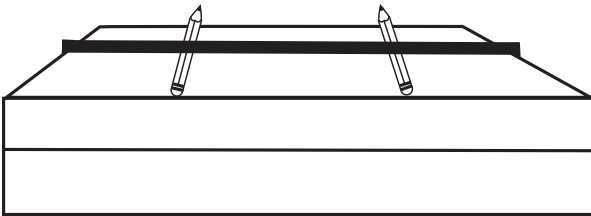
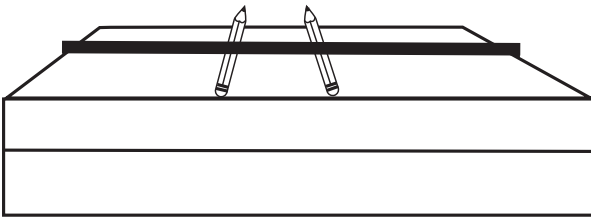
Draw a picture, below, of the rubber band on your hand at the three different distances. Imagine you can see the sound waves coming from each rubber band as you pluck it. Draw what you imagine each wavelength looks like coming from each rubber band.



DOING THE WAVELENGTH-PAGE 2

2. The length of the sound waves changes with the distance the pencils are from each other. When the pencils are closer, the length of the sound wave is longer than when the pencils are farther apart. Can you hear a difference between the sound waves that occur at three different lengths? Describe or draw the differences you hear.

Describe the sound wave



Light Lab #2: Meet Roy G. Biv–Instructions

Materials

- Lab sheet, pencil
- Red, orange, yellow, green, blue, indigo (purplish blue), and violet (purple) colored pencils, crayons, or markers

Aloud: Have you ever wondered what makes one color different from another? Would you be surprised to hear that a property of light makes one color, like yellow, look different from another color like blue or red? Specifically, it is the wavelengths of light that makes colors look different. The wavelength for yellow light is different from that for blue or red light. Blue and red light have different wavelengths from each other too. Stars that are very hot emit more blue light, and stars that are cooler than our sun emit more red light. Astronomers can also use the wavelengths a star emits to tell them about the materials that make up the star.

In today's activity, you will make a poster showing the wavelengths of the colors. The color is related to the amount of energy carried by the wave. You will also learn an acronym for remembering the order of the wavelengths of colors. An acronym is an abbreviation formed from the first letter of words. When colors are separated out by a soap bubble, DVD, prism, or in a rainbow, they separate in the order of their wavelengths which is the same order they are in the acronym, ROYGBIV: Red, Orange, Yellow, Green, Blue, Indigo, and Violet. To help you remember the wavelength order of the colors, let me introduce you to a really colorful guy, Roy G. Biv.

Procedure

Color each strand of hair the appropriate color. Starting on the left the colors are: red, orange, yellow, green, blue, indigo, and finally violet. Write the first letter of the color for each hair strand spelling ROY G BIV. If you wish, color the rest of Roy the colors of the rainbow.

More Lab Fun

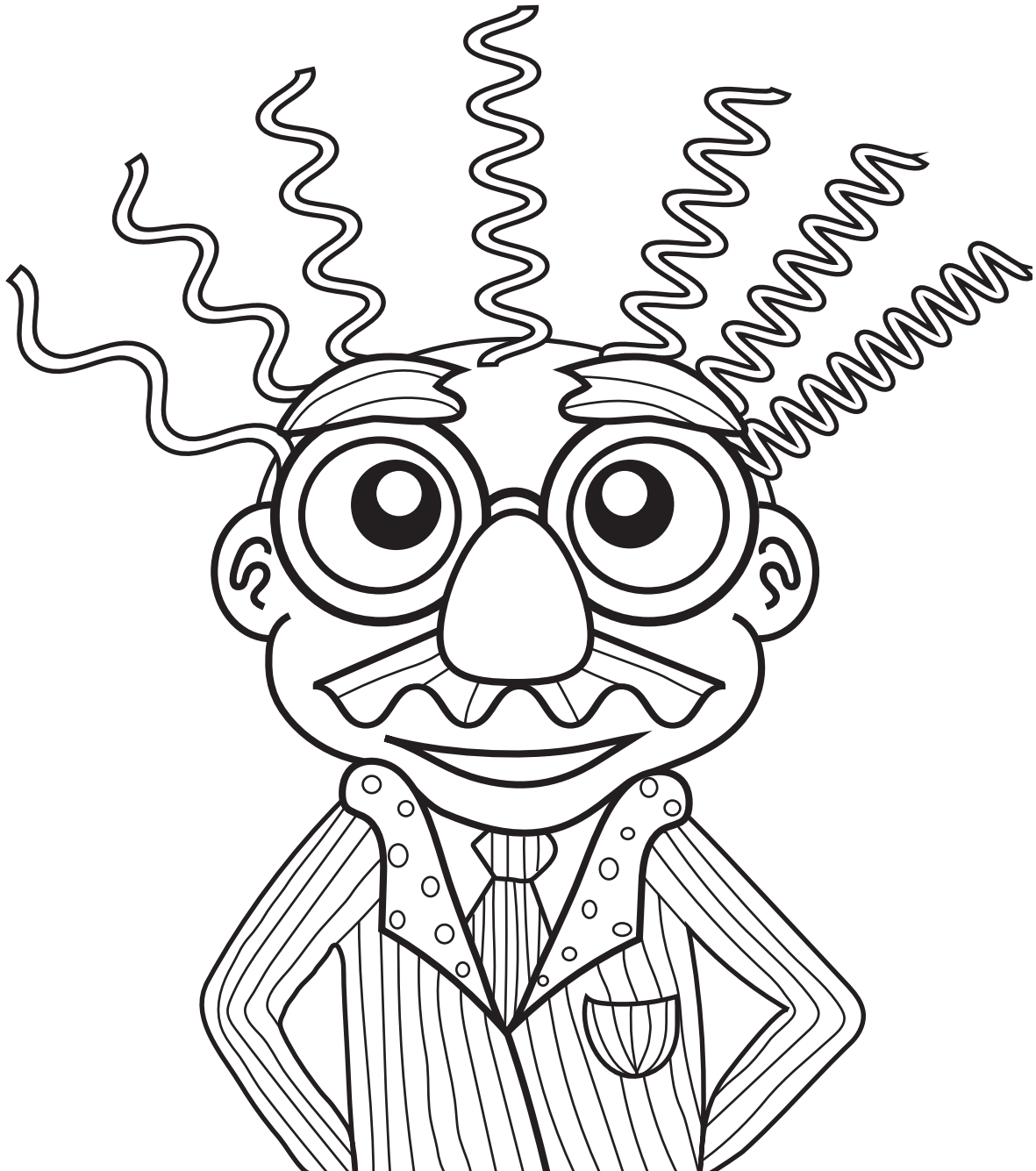
The next time you see a rainbow check out the order of the colors.

Instructor's Notes

- Wavelengths are measured in nanometers (nm). Each color in the visible spectrum of light spans a wavelength measurement. For example, red has a wavelength between about 620 and 750 nm.
- Astronomers can also use the wavelengths a star emits to tell them the types of material that make up the star and the amount of material. The amount of material a star is made of is the mass. Mass is not covered in this level. It is first covered in more detail in RSO Chemistry 1.
- The visible spectrum is the portion of the electromagnetic spectrum that is visible to the human eye. A typical human eye will respond to wavelengths from about 400 to 700 nm. Quite a few animals can see colors that humans cannot. Bees and butterflies, for example, can detect ultraviolet light but they cannot detect red.

NAME _____ DATE _____

MEET ROY G. BIV



Light Lab #3: Mixing and Separating Light–Instructions

Materials

- Lab sheet, pencil
- 4 flashlights
- 1 piece each of red, green, blue, and yellow cellophane (pieces need to be large enough to tape around the end of the flashlights)
- Tape
- Another person to help hold the flashlights
- Compact disc, plain with no labeling or graphics
- Red, orange, yellow, green, blue, indigo, and violet colored pencils, crayons, or markers
- Smooth, white wall, ceiling, paper, or other surface to shine the lights on

Aloud: Do you like mixing colors together to create new colors when you paint? Do you remember what color you get when you mix red and green paint together? Brown, most likely. What color would you use to paint light? What color is light? Do not think hard about it; just answer the first thing that pops into your head. If you are like most people you will say that light is white. But white light is what you see when all the wavelengths of light—red, orange, yellow, green, blue, indigo, and violet—are added together! To make white light, you need to have at least red, blue, and green. If you mix some of the ROYGBIV wavelengths of light together but don't include red, green, and blue, you would not get white light. And if you mix red and green light together, you will get yellow light! Let's experiment and see what colors occur when we mix different wavelengths of light together.

Procedure

1. Cover each flashlight with a different color of cellophane. Tape the cellophane around the edge of the flashlight.
2. Start by shining each of the flashlights one at a time on a white surface. You are confirming that each of these flashlights, by themselves, shine the same color as the cellophane. This might work better if the room's lights are dimmed or turned off.
3. In the order shown below, mix the light colors by shining the indicated flashlights onto the same spot. After mixing each, color the corresponding image on the lab sheet by coloring the beam coming from each flashlight. Instead of a beam of light, advanced students could draw colored wavelengths coming from each flashlight that vary in length depending on color (i.e. long wavelength for red light, short for blue, etc.). Color the middle circle the color that results when the different lights are combined. Complete the corresponding row in the table.
 - #1. Shine the red and blue flashlights onto the white surface.
 - #2. Shine the red and green flashlights onto the white surface.
 - #3. Shine the red and yellow flashlights onto the white surface.
 - #4. Shine the blue and green flashlights onto the white surface.
 - #5. Shine the blue and yellow flashlights onto the white surface.
 - #6. Shine the blue, green, and red flashlights onto the white surface.
 - #7. Shine the blue, green, red, and yellow flashlights onto the white surface.

Aloud: Were you surprised by the color of light that resulted from any of the combinations? Now that you have mixed the colors of light, let's separate them. You see the colors of light separated every time you see a rainbow. Each day as sunlight streams from the sun, the light wavelengths are combined and the sunlight appears white. When sunlight goes through raindrops, though, the

[continued]

combined wavelengths separate into the colors of the rainbow! But you don't have to wait for a rainy day to see a rainbow. You can see the separation of light with a CD and a light source.

Procedure

4. Shine each cellophane covered flashlight one at a time on the side of the CD. Answer #8.
5. Take the cellophane off of one of the flashlights and shine the white light onto the CD. Play around with the angle until you can see the series of wavelengths. Answer #9.

Answers

- #1. red + blue = magenta/purple
- #2. red + green = yellow
- #3 red + yellow = green
- # 4. blue + green = turquoise
- #5. blue + yellow = white
- #6. blue + green + red = white
- #7. blue + green + red + yellow = white
- #8. The colors stay true to the color of the cellophane.
- #9. Yes

More Lab Fun

- Next time you blow bubbles look for the separation of sunlight into colors on the bubbles.
- If you look at a TV screen up close with a magnifying glass, you will be able to see that only red, blue, and green light colors (RBG model) are being emitted. They are also being combined to create other colors. For example, you'll see tiny red and green lights overlapped to portray a yellow color.

Instructor's Notes

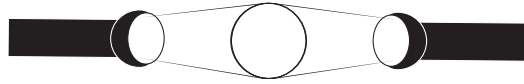
- Are you wondering what is going on with the way wavelengths of light mix to make colors? Red and green light mix together to make yellow, which is a color whose wavelength range is between red and green. Therefore, when blue is added to yellow it is the same as adding blue to red and green. Those three primary colors of light (red, blue, and green) added together produce white light which is what you observe in this lab.
- As light passes through a prism, different wavelengths refract (bend) at different angles and disperse (separate) making the colors of the visible spectrum.
- The primary colors of light are red, blue, and green. The primary colors of pigment (paint) are red, blue, and yellow (more accurately—magenta, cyan, and yellow).
- The reason that light color does not behave like paint color has to do with additive versus subtractive color and how light wavelengths work with surfaces—physics concepts beyond the scope of this course. However, if your student is asking for an explanation, you could try explaining it this way: Paints (and crayons, dyes, markers, etc.) are pigment not light, so in science they behave differently than light. Pigments are made of chemicals that absorb some wavelengths and reflect others. So when white light (which contains red, blue, and green wavelengths) shines on a pigment, you only see the wavelengths that are reflected back to you. When pigment colors are combined, you only see the colors that none of the pigments in the mixture absorb. For example, blue pigment absorbs red, and yellow pigment absorbs blue. But neither blue nor yellow pigment absorbs green, so the combination of blue and yellow pigment results in green light being reflected back.
- Things (pigments) appear black in color because all the colors of light are absorbed and they appear white in color because all the colors of light are reflected. All the other colors we see are variations between these two extremes.

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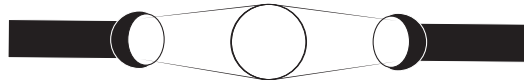
MIXING AND SEPARATING LIGHT

Mixing Light

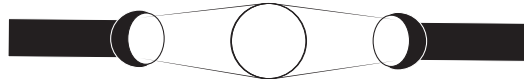
1. Red light + Blue light
= _____ light



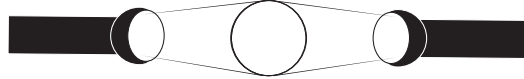
2. Red light + Green light
= _____ light



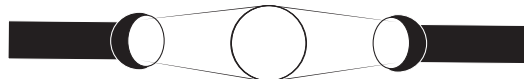
3. Red light + Yellow light
= _____ light



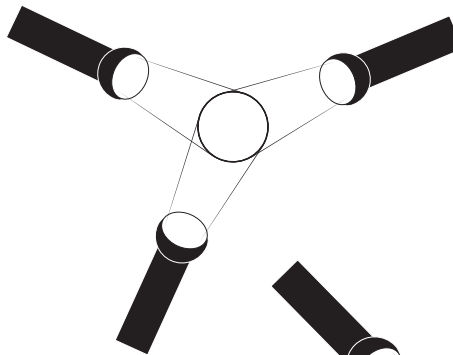
4. Blue light + Green light
= _____ light



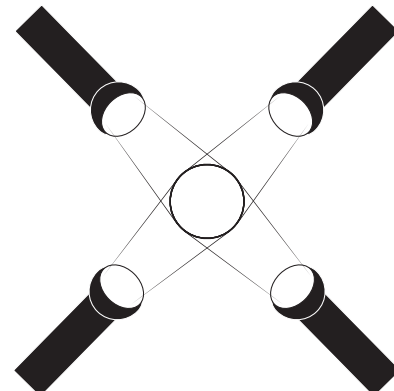
5. Blue light + Yellow light
= _____ light



6. Blue light + Green light
+ Red light
= _____ light



7. Blue light + Green light
+ Red light + Yellow light
= _____ light



MIXING AND SEPARATING LIGHT-PAGE 2

Separating Light

8. What color does each cellophane colored flashlight shine on the CD?

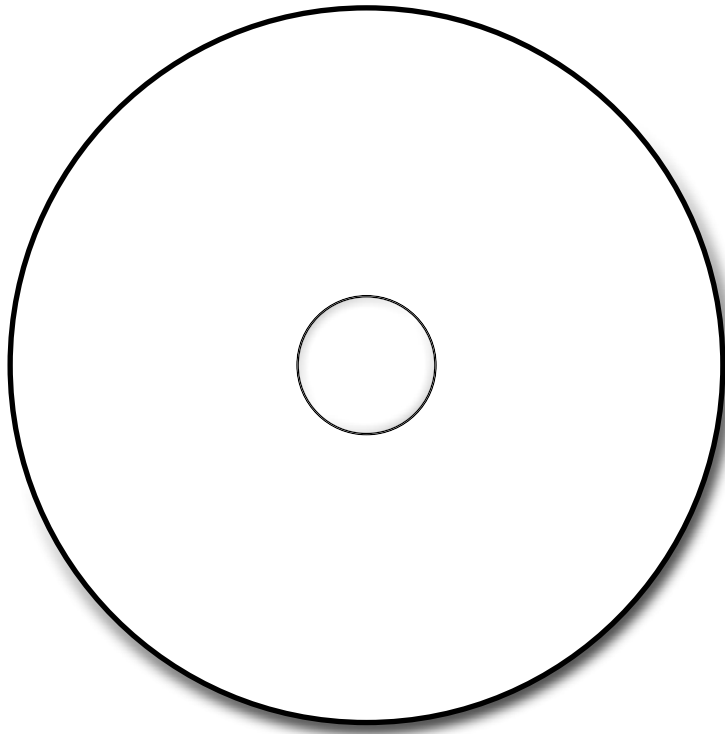
Blue =

Green =

Red =

Yellow =

9. Draw and color the series that you see when you shine white light on a CD.
Does it follow the pattern ROYGBIV?



Light Lab #4: The Highs and the Lows of Wavelengths–Instructions

Materials

- Lab sheet, pencil
- Space to jump around

Aloud: Waves of light can have different lengths. They can also have different amplitudes. Amplitude is a measurement of the height of a wave. Astronomers use the amplitude of a wave to learn about the energy coming from a star. The temperature and size of a star affect the energy carried by the light waves it produces. Light waves from small, cool stars have lower amplitudes which tell scientists that the star produces less energy than a larger, hotter star. It is easy to learn about the relationship between amplitude and energy by getting up right now and jumping around!

Procedure

1. Give a very small hop. Did that take a lot of energy? Did you get very high off the ground?
2. Give a medium-sized jump. Did that take more energy? Did you get higher off the ground? The distance from the ground is the amplitude of your jump. Which jump had higher amplitude?
3. Jump as high as you can. Which of the three jumps took the most energy? Was the amplitude higher or lower for this jump than it was for the other two.
4. Complete the lab sheet.

More Lab Fun

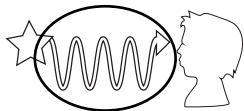
Bounce a ball back and forth changing the amplitude with each bounce.

Instructor's Notes

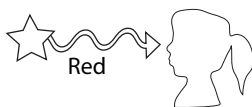
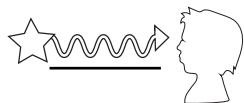
- The relationship between energy and amplitude used in this activity does not align perfectly. In order to get greater amplitude while jumping, students had to *exert* more energy. For stars, the greater the amplitude of the waves, the more energy the star *emits*. The important thing for students to understand is that there is a direct relationship between energy and amplitude.
- In this course, for simplifying purposes, the discussion of the intensity of light ignores the particle nature of light. Intensity is a measure that involves power (energy per unit time) and area (intensity is power per unit of space).

Answers

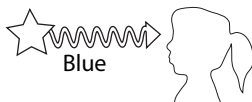
The higher the amplitude of the jump, the greater the energy it took to jump.



These stars are emitting different amounts of energy, but are the same color (wavelength is the same).



These stars are emitting the same amount of energy, but are different colors (wavelength is different).



NAME _____ DATE _____

THE HIGHS AND THE LOWS OF WAVELENGTHS

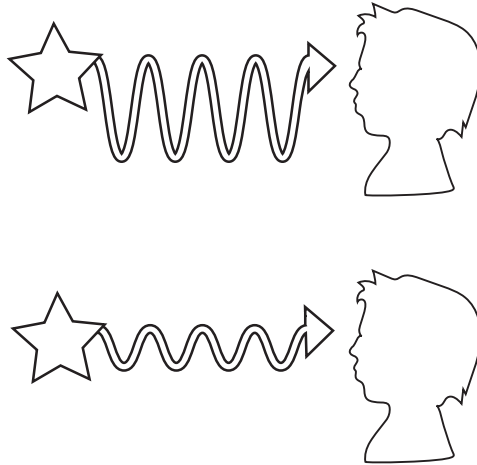
Jump #1. Did that take a lot of energy? Did you get very high off the ground?

Jump #2. Did that take more energy? Did you get higher off the ground? The distance from the ground is the amplitude of your jump. Which jump had higher amplitude, Jump #1 or #2?

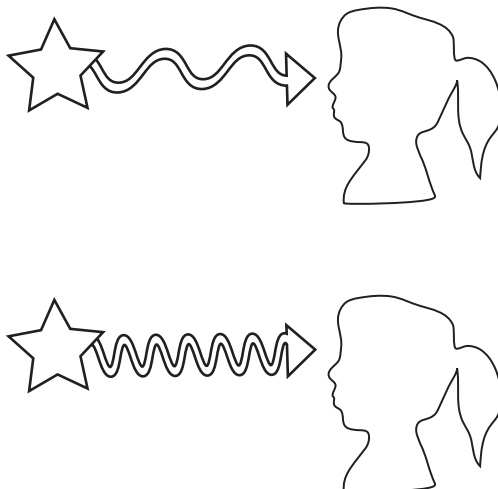
Jump #3. Which of the three jumps took the most energy? Was the amplitude higher or lower for this jump than it was for the other two?

THE HIGHS AND THE LOWS OF WAVELENGTHS-PAGE 2

The wavelength coming from these two stars is the same. That means that the stars are shining the same color of light. The amplitude of these two lines is different. That means that the intensity of the light is different. Circle the wave series with the higher amplitude. Draw a line under the wave series that is coming from a star that puts out less energy.



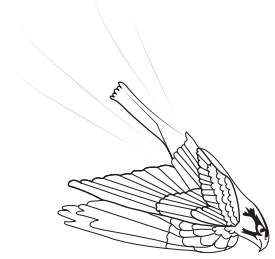
These two wavelengths of light are coming from two different stars. Do the stars have the same amount of energy or different amounts of energy? One of these series is the correct wavelength for red light and one of them is for blue light. Color each wavelength the correct color.



Light Lab #5: The Speed of Light–Instructions

Materials

- Stopwatch
- Flashlight
- Two extra people



Aloud: Light travels from its source at a speed called the speed of light. In space, where there is nothing to interfere with light, all light travels at the speed of light, no matter what its wavelength is or its amplitude. How fast are you? Would you say you are very fast? At top speed, 121 kph (75 mph), cheetahs are the fastest land animal. Peregrine falcons are the fastest birds at 386 kph (240 mph). Sailfishes speed through the water at 109 kph (68 mph). You probably are not as fast as any of them. No matter how fast you, cheetahs, peregrine falcons, or sailfishes are, none of you are even close to the speed of light. In fact, nothing can travel faster than the speed of light. Just how much faster is the speed of light than you are? Let's experiment and find out.

Procedure

1. Have one person hold a stopwatch and walk 5 to 15 meters away from the other two people. The distance is not really important.
2. Have the other two people line up next to each other at a starting line facing the person with the stop watch. One person is going to run and the other person is going to turn the flashlight on. The person who is running is racing the light from the flashlight.
3. The person with the stop watch will call ready, set, go and then turn the stop watch on. When go is called, the person running takes off toward the person with the stop watch. At the same time the person with the stop watch will turn on the flashlight.
4. There is no lab sheet. Instead discuss the difference in time it takes someone to run compared to how fast light traveled to the observer with the stop watch. Have each student observe and run, so that they can get both perspectives.

Instructor's Notes

- Light travels at 186,282 miles per second (299,792 kilometers per second).
- Light-year is introduced in the next section.
- You can observe how much faster light waves are than sound waves with lightning and thunder during a storm.

For my notebook

THE UNIVERSE

Astronomy is the study of the universe. The universe consists of everything in space and on Earth, including you. The universe even includes time—past, present, and future.

Scientists use scientific models when studying the universe. Scientific models are very important tools used by scientists in every area of science. They are used to describe and predict things in the real world. There are three types of scientific model: visual models, computer models, and mathematical models. A visual model is a visual representation of an object or system. If you have ever made something with LEGO bricks, then you have made a visual model. A computer model uses a computer program to predict what will happen or what has happened. When you hear on the news that it is supposed to rain tomorrow, that prediction came from a computer model. A mathematical model uses math equations to explain something in science. When scientists study the universe, they use all three types of models to explain how the universe began, evolved to its present state, and will continue to evolve.

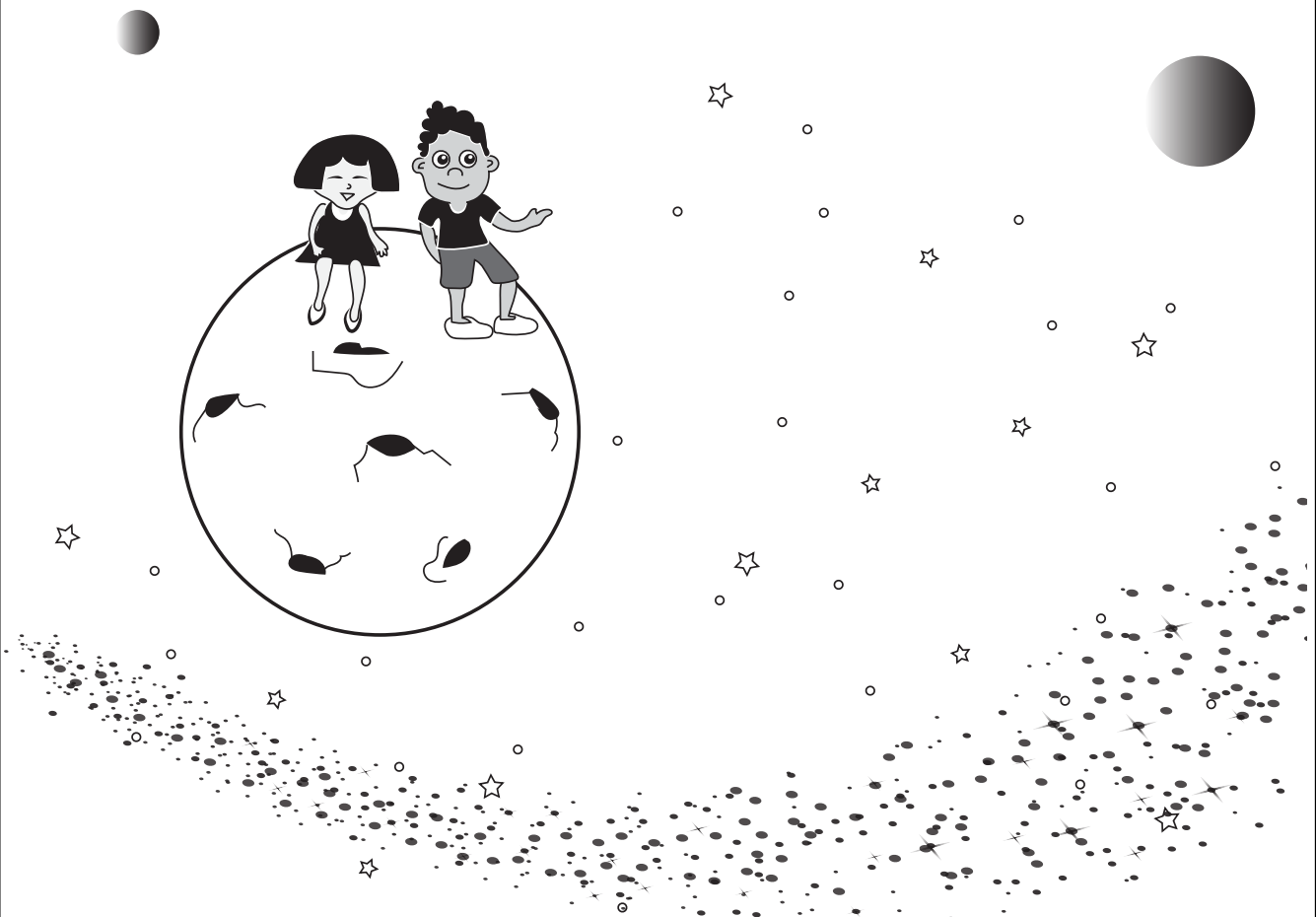
The event that started the universe is called the Big Bang. It occurred 13.82 billion years ago. The name of the scientific model describing how the universe got its start, the Big Bang model, is a little misleading. Based on its name, you probably think it started with a very loud bang. Actually, there was no noise at all. For there to be sound, there needs to be particles, and there were not any atoms, the particles that make molecules, until 380,000 years after the Big Bang occurred.

When you look up into the sky you are looking at the part of the universe you can see from where you live. The universe is huge and vast. Even with a powerful telescope, astronomers cannot see the end of it.

For my notebook - page 2

What do you think is in the universe? There probably are solar systems like this one, as well as stars being born, dying, and going supernova (exploding). There are black holes where the gravitational pull is so strong that light is pulled into them. Scientists have observed a planet where it rains diamonds, a star that is 1,500 times larger than the sun, rings of rock and ice surrounding an asteroid, and water (something scientists think is essential for life) on moons and dwarf planets.

The next time you sit outside at night looking at a star, use your imagination. How old is the star? Are there planets and moons orbiting the star? Could there be life on any of them? Is it possible that there is a girl or boy sitting on one of the planets wondering if there is life outside of her or his solar system?



Universe Lab #1: It Started with a Bang–Instructions

Materials

- Lab sheets, pencil
- Colored pencils
- Scissors
- Glue or tape
- Large sheet of construction paper 12" × 18"

Aloud: The universe started as pure energy. It sounds like something out of a sci-fi movie, but from that pure energy came everything in the universe. Today you are going to color the visual model that scientists made to show when things started to form after the Big Bang. If you have ever made a timeline of the history of Earth and living things, the Big Bang was probably not on it. That is because the Big Bang happened 9.32 billion years before Earth formed.

Procedure:

1. Color and cut out the Timeline Badges on the lab sheet. The badges depict the following events:
 - #1. Big Bang
 - #2. Atoms form
 - #3. Stars form
 - #4. Solar system forms
 - #5. Earth forms (shown as Pangaea)
 - #6. Life evolves
 - #7. Humans evolve
2. Remove the Big Bang lab sheets, cut around each page's outline, and glue or tape the two-page spread to the construction paper.
3. Glue the Timeline Badges to the Big Bang Model lab sheet spread. Color the rest of the model. Discuss how huge the amount of time is between events.

Instructor's Note

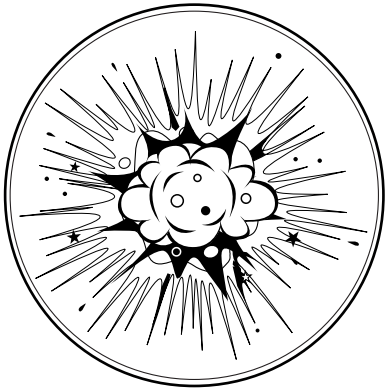
This is an advanced topic that is not included in most early elementary courses. I include it for three reasons. The first is that there is an emphasis on scientific modeling throughout this course. The Big Bang model is one of the most important scientific models in astronomy, which makes it a great model to cover. The second has to do with literacy of core science topics. It is important to introduce vocabulary and ideas for these complicated topics early so that when students are ready for a more advanced approach they have some literacy around the topic and can therefore begin their study at a higher level. The third reason is that the topic is fascinating!

More Lab Fun

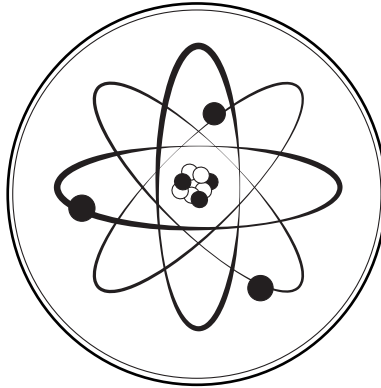
If you have a geological timeline like the one students make in RSO Earth & Environment 1, you can make a copy of the Big Bang badge, color it, and place it to the left of your geological timeline, before Earth formed.

NAME _____ DATE _____

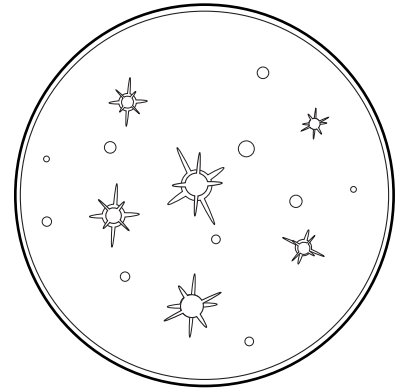
IT STARTED WITH A BANG—TIMELINE BADGES



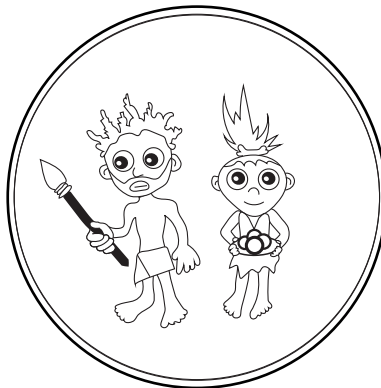
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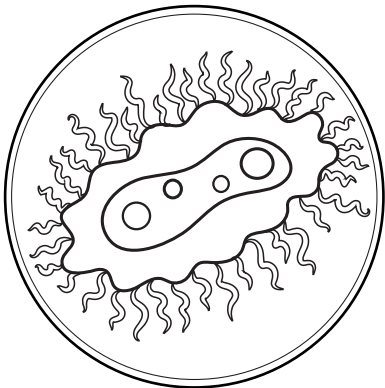
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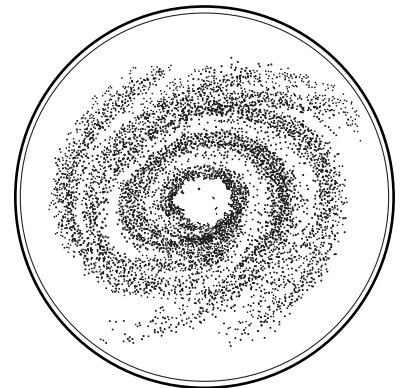
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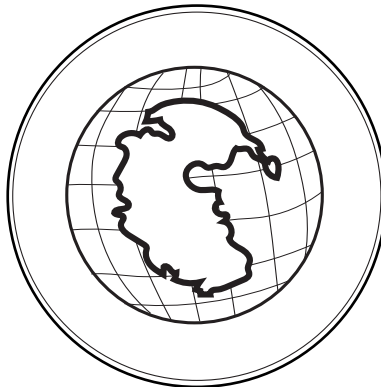
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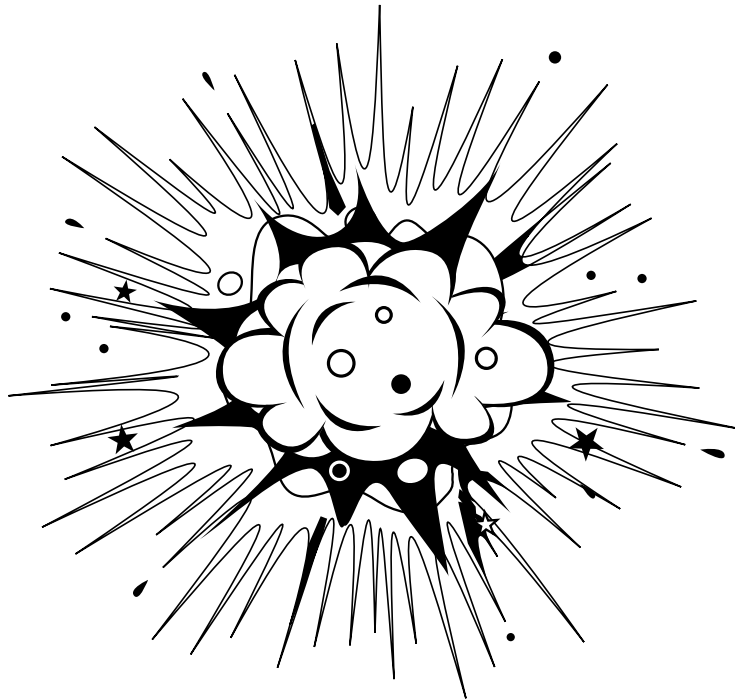
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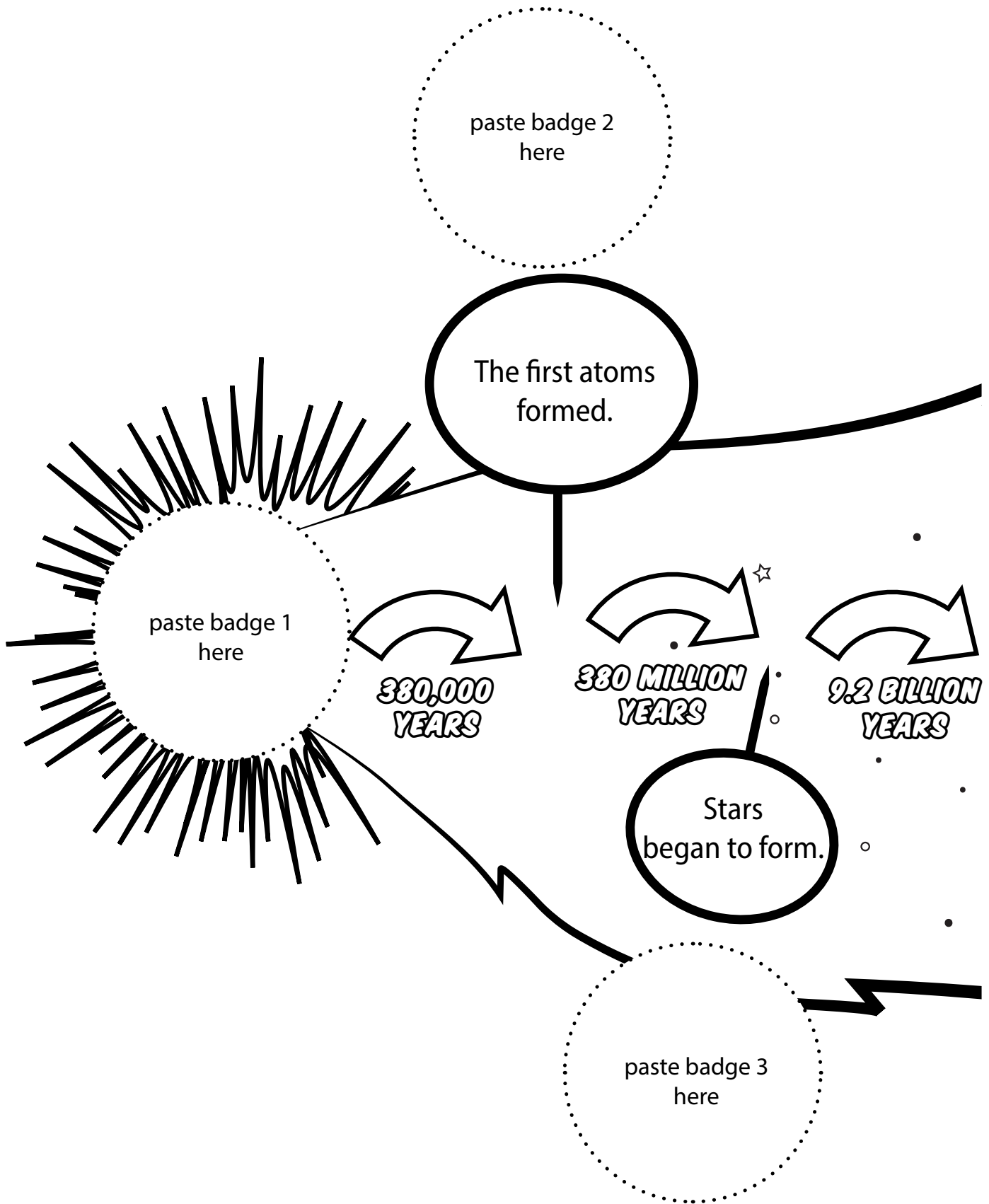
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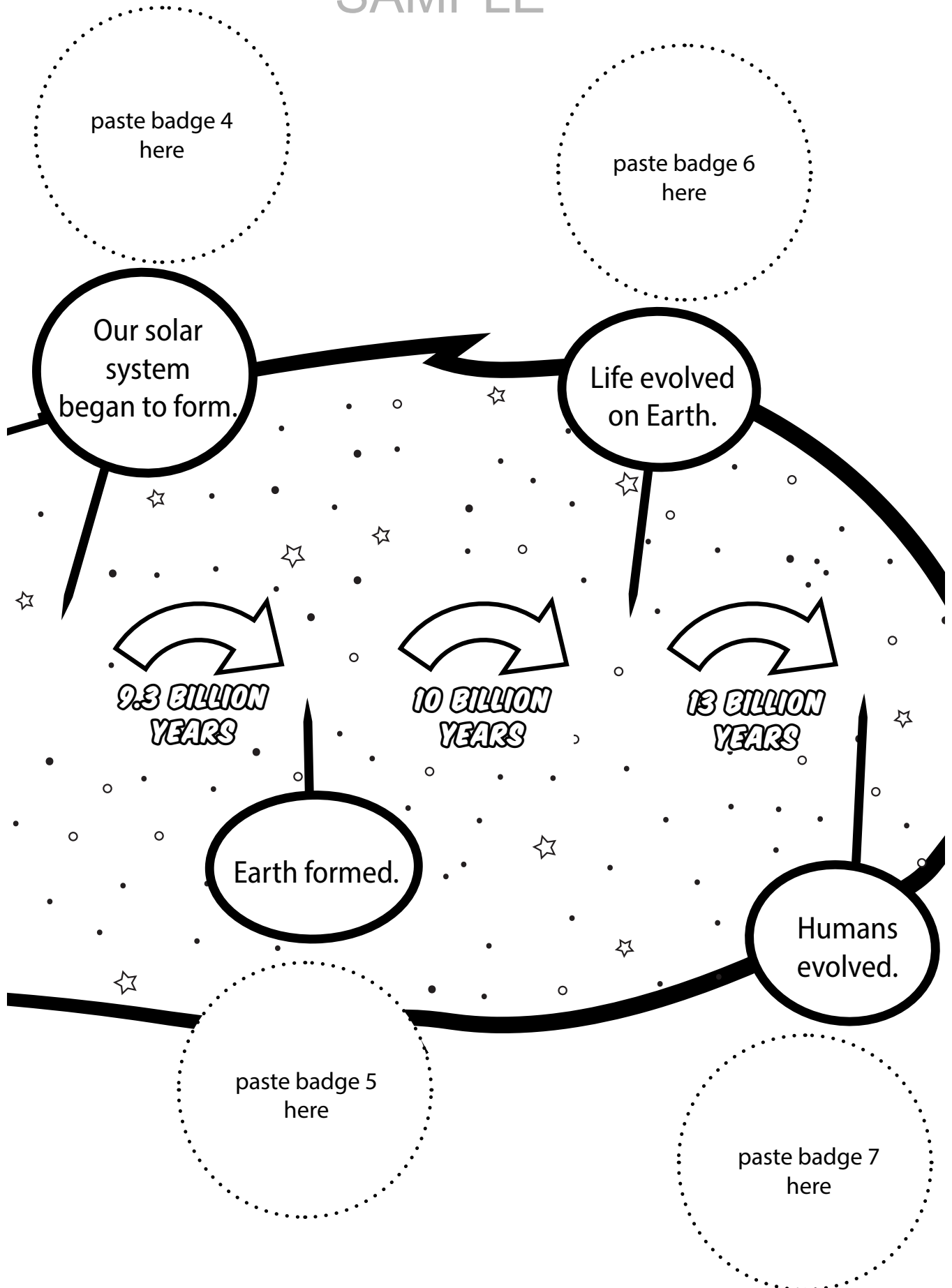
NAME _____ DATE _____

MY BIG BANG MODEL



SAMPLE





Thank you for previewing RSO Astronomy 1. We hope you are enjoying the course so far.

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