LAUNCHING OUR MINDS with STEM

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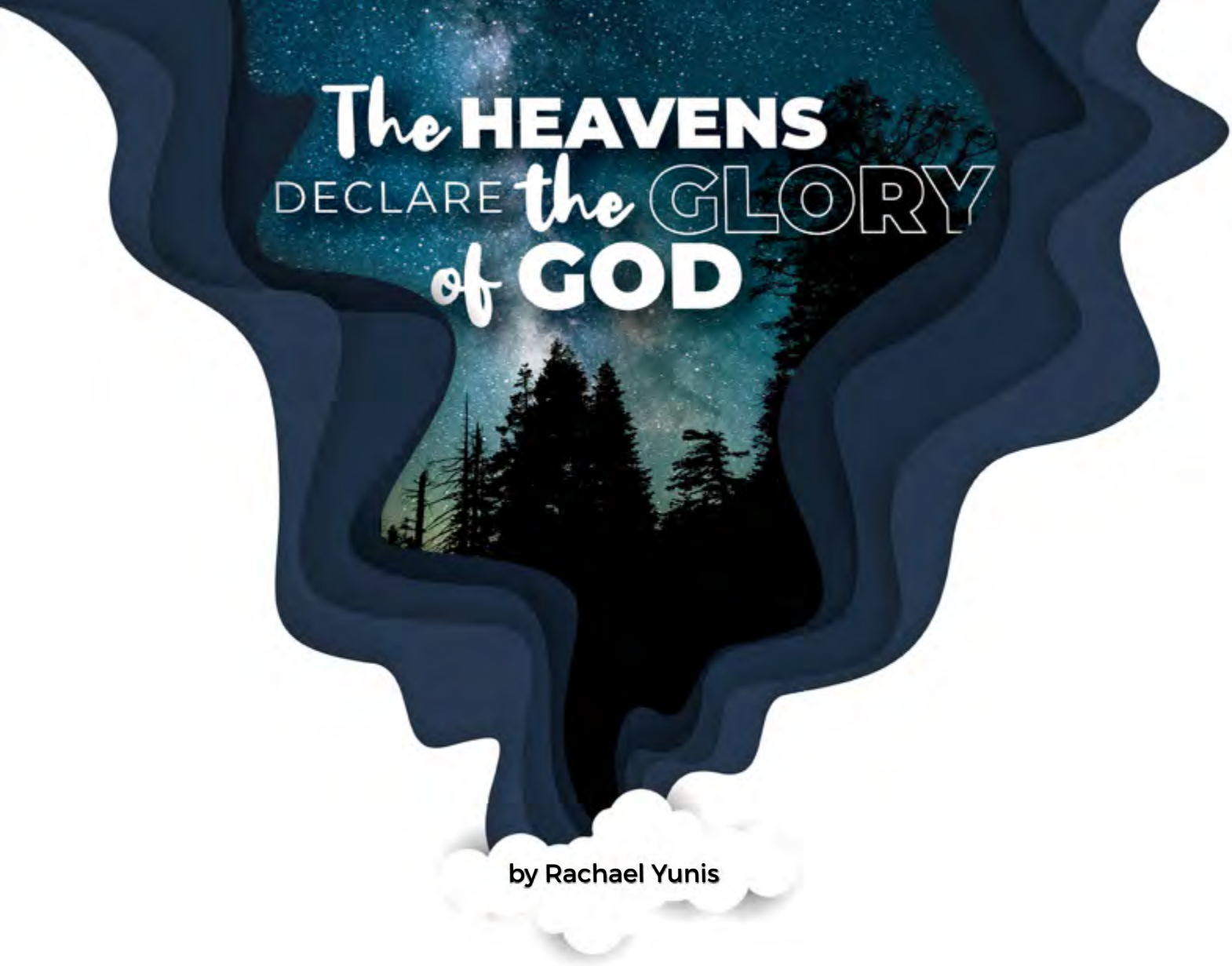


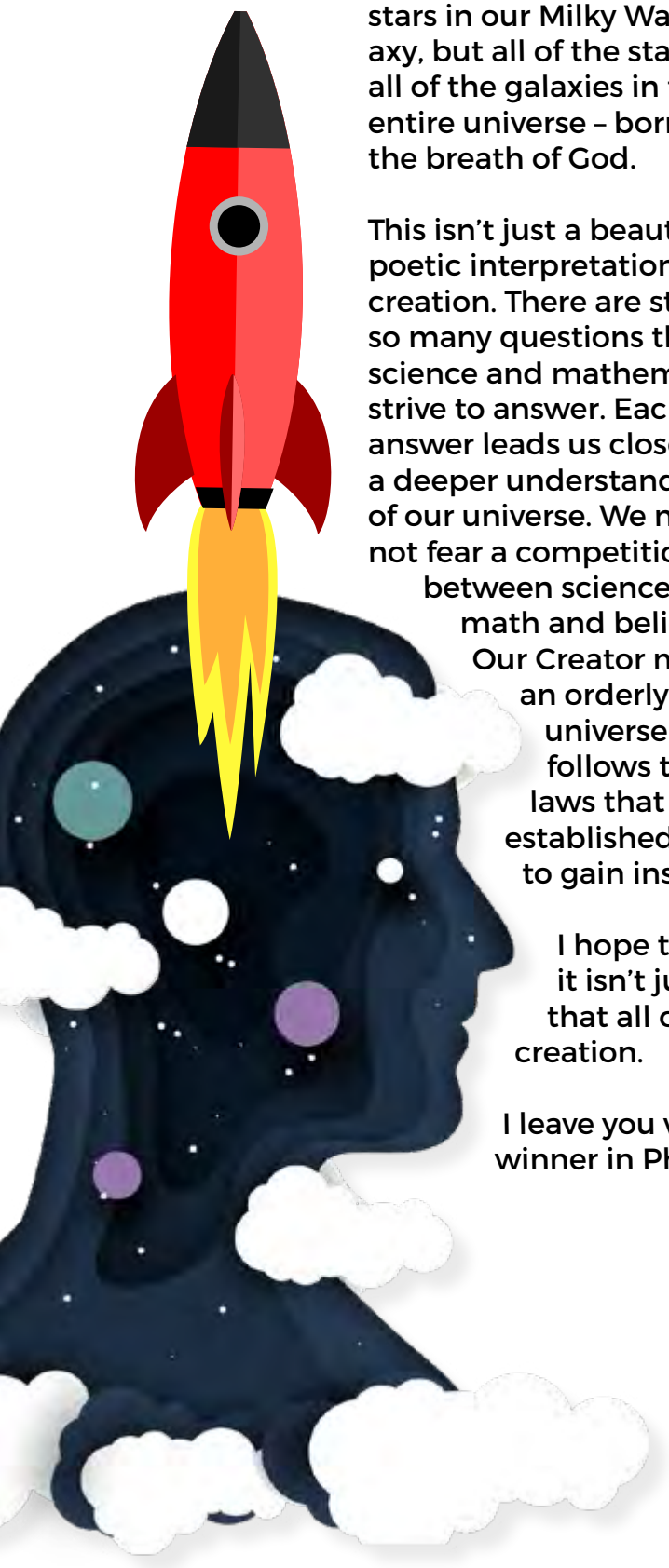
by Rachael Yunis

Have you ever been blessed with the opportunity to look up at a night's sky so glorious that you forgot that your feet are fixed upon the Earth? It's hard to find a spot dark enough to see a true night sky, but if you are ever out on a back-country road and away from the light of local cities, I encourage you to take some time to stop and contemplate the heavens. I promise you that you won't be disappointed. You will not only see, but also experience, the heavens. You will feel God's omnipotent presence.

God's signature is visible throughout creation. The Bible tells us, "Ever since the world was created, people have seen the earth and sky. Through everything God made, they can clearly see his invisible qualities–his eternal power and divine nature. So they have no excuse for not knowing God." Romans 1:20, NLT

Experiencing God's signature, in all of its majesty, brings us closer to our Creator and inspires us to strive for greater things. At Apologia Science, we believe the words of the Bible, "The Lord merely spoke, and the heavens were created. He breathed the word, and all the stars were born." Psalm 33:6, NLT

I think about that verse and try to understand everything that it is teaching us. Not only our star, the sun, not only all of the stars in our Milky Way Galaxy, but all of the stars in all of the galaxies in the entire universe – born by the breath of God.



This isn't just a beautiful, poetic interpretation of creation. There are still so many questions that science and mathematics strive to answer. Each answer leads us closer to a deeper understanding of our universe. We need not fear a competition between science, math and belief. Our Creator made an orderly universe that follows the laws that He established. Science and mathematics merely use that order to gain insight.

"My job is simply to do good science," Guy Consolmagno in Science magazine.
Photo Credit: Yunis

I hope that the next time you glance up at the night's sky it isn't just to locate the Big Dipper or Orion's belt. I pray that all of your future star gazing be an effort to get lost in creation.

I leave you with a quote from Arthur Compton, Nobel Prize winner in Physics, 1927 and the Franklin Medal in 1940.

For myself, faith begins with a realization that a supreme intelligence brought the universe into being and created man. It is not difficult for me to have this faith, for it is incontrovertible that where there is a plan there is intelligence—an orderly, unfolding universe testifies to the truth of the most majestic statement ever uttered—'In the beginning, God.'

INTERVIEW with a VATICAN Astronomer

CLICK HERE FOR LINK TO INTERVIEW VIDEO

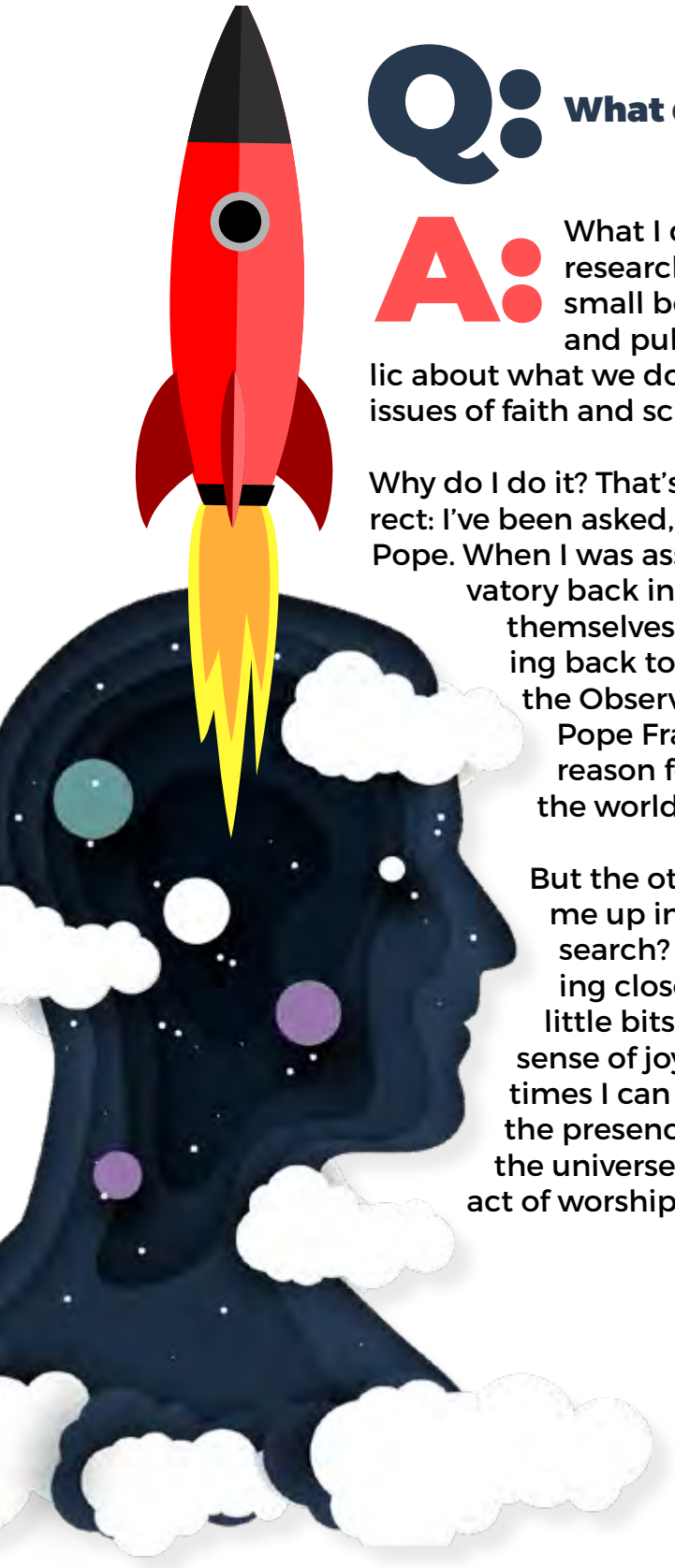
I first met Brother Guy Consolmagno, Director of the Vatican Observatory, through his writing. The book that got me hooked was, *Way to the Dwelling of the Light: How Physics Illuminates Creation.*

Two excerpts from the foreword can easily explain why I used it in my homeschool science planning:

> A lot of people talk about the "split" between science and religion, as if no scientist could believe in God and no religious person show an interest in Einstein. That's silly, of course. You obviously don't have to give up God to study His creation: most of the great scientists in history, including Copernicus, Kepler, Newton, James Clerk Maxwell, Marconi, and Einstein himself, called themselves believers.
>
> Getting to know How God Did It ought to be a wonderful way of celebrating God's grandeur. It's traditionally been a form of worship that western religion had always embraced, until the late 19th century...when this canard of a split between science and religion took hold. Science is too important to our lives to ignore. It's too much fun to leave to the atheists. And it's too Good not to be used as a way of getting to know the Lord Who Created Heaven and Earth; Who can be found, with His first creation, at home in the Dwelling of Light.

Being a scientist, veteran homeschooling mom of three boys, and the wife of a NASA engineer (see the interview with Sam Yunis) made it easy for me to fall in love with any material I

could use to grow my faith and scientific knowledge. Over the years, my family and I continued to read and enjoy Brother Guy's resources. His materials helped influence my oldest son, a graduate of Virginia Tech, get a job working with rockets at NASA. Here are Brother Guy's responses to my interview questions.



Q: What do you do and why do you do it?

A: What I do is direct the Vatican Observatory; do scientific research on the origin of meteorites, asteroids, and other small bodies in the solar system; and write popular articles and public talks as a way to reach out to the general public about what we do at the Vatican Observatory, including the bigger issues of faith and science.

Why do I do it? That's actually a profound question. One answer is direct: I've been asked, both indirectly and directly, to do this work by the Pope. When I was assigned to be an astronomer at the Vatican Observatory back in 1993, I was obeying my Jesuit superiors who were themselves responding to continual requests from Popes going back to Pope Leo XIII in 1891. When I was made director of the Observatory in 2015, it was at the direct appointment of Pope Francis himself. In both cases, you could say that the reason for the work was, in the words of Pope Leo, to show the world that the Church supports good science.

But the other side of the question is more subtle: what gets me up in the morning and makes me excited to do the research? And that is simply, the joy that I experience in being close to creation, the fun that I have seeing how all the little bits that I discover fit together with each other. That sense of joy reminds me strongly of the kind of joy that sometimes I can experience when I pray. I identify it as recognizing the presence of God, both in my prayer and as the Creator of the universe that I am studying. So, we do science literally as an act of worship.

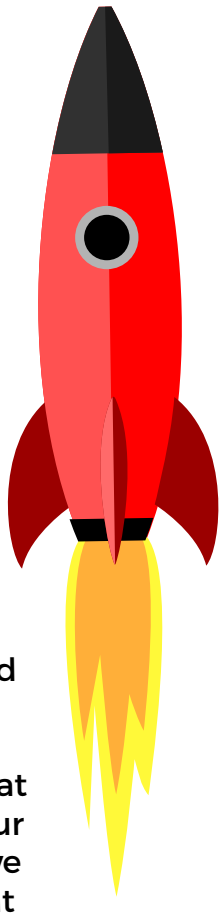
Q: What's the coolest thing you've ever seen, contemplated, or experienced in science?

A: Most of science is not any one great breakthrough but a steady stream of small but fun discoveries. The most re-

cent one I can think of is when I was puzzling, for more than a year, about how the results from the NASA mission to asteroid Vesta could be fit into my long-standing theories about how asteroid Vesta evolved. And there finally came a moment when I realized, my models were wrong. My theory was wrong. I had to come up with a completely new way of looking at the problem. And that was a thrilling, liberating experience.

Q: How does your knowledge of both science and faith affect how you look at the universe?

A: I am reminded of stories I have read about the children of celebrities, and what happens when they realize that their moms or dads are famous. Every small child thinks their daddy is a rock star; it can come as a shock if it happens that their daddy really is a rock star, with a dozen albums and millions of fans around the world. That's our experience with God the Creator. We know God first as Father, "Abba" — "Daddy", in other words. We know God intimately as someone who loves us. And then we discover that this same God who is so close to us, is also the God who makes black holes and supernovae, and the experience is simply stunning.



Q: What would you have young people contemplate?

A: Ask yourself exactly these same questions that you have asked me. What are you doing, and why are you doing it? Where do you find joy — which is to say, where does God reveal himself to you? This is a good hint of the sort of work, the vocation, that you should be pursuing. We can't all be astronomers but we can all have our own unique calling. We find that calling by discovering the places where we most often find God: the work that fills us with enthusiasm, the setting that fills us with joy. You have to try out a lot of different possible places and works before you can discover the one that fits your call.

Then, ask yourself, what's the coolest thing you've ever seen? Keep an eye out for it; you don't want to miss it! Sometimes, that experience is recognizing that you had made a mistake. Don't be afraid of mistakes; recognizing and correcting them can lead to some of the most delightful experiences in life.

And finally, ask yourself how your faith affects the way you view your own universe. If you see the world no differently than someone who doesn't know God, then what's the point of your faith? Your faith is the salt of your life; it should flavor everything you experience and entice you to want to experience life even more deeply.

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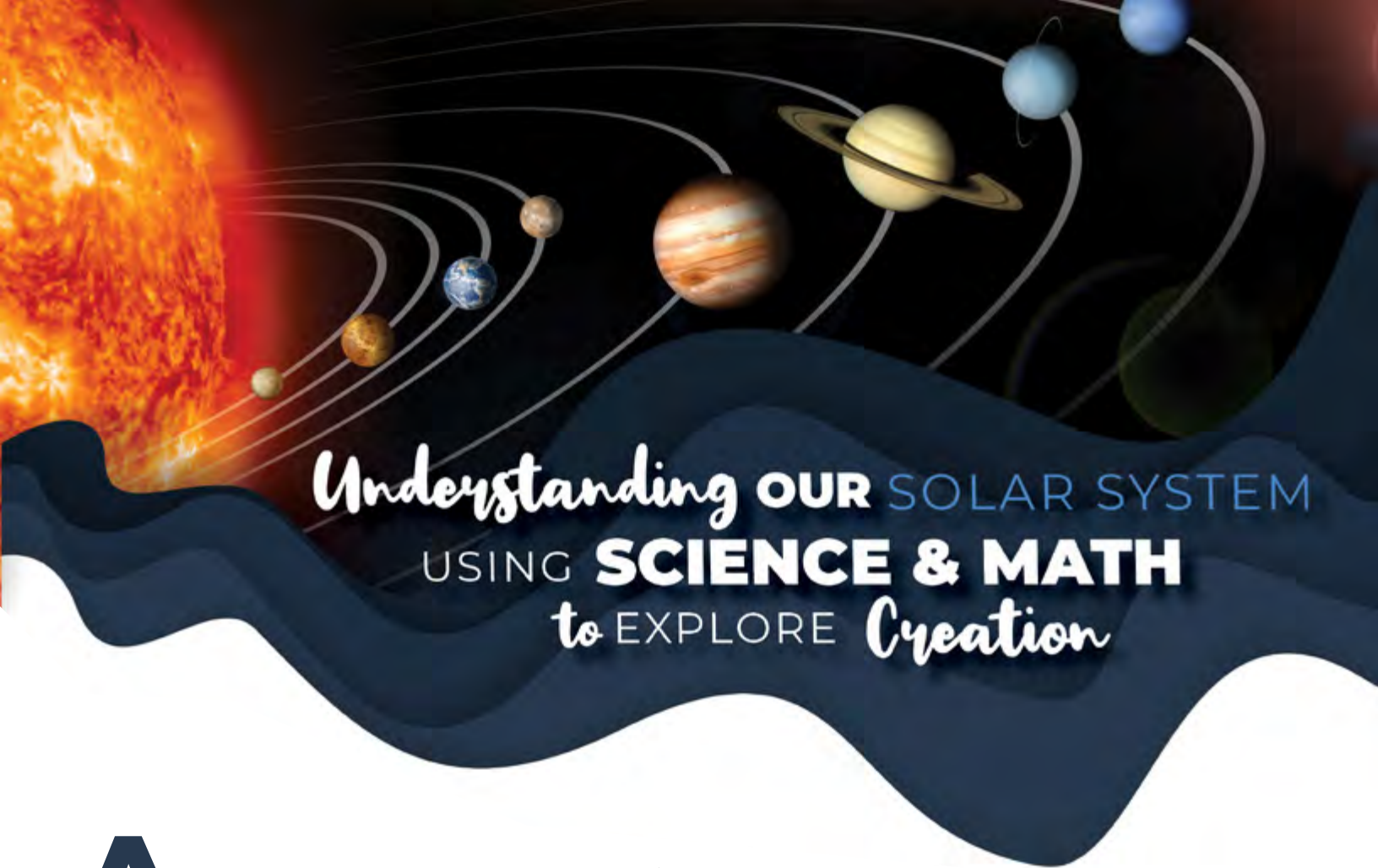


Understanding OUR SOLAR SYSTEM USING SCIENCE & MATH to EXPLORE Creation

A star, such as our sun, and all the objects that travel around it — planets, moons, asteroids, comets and meteoroids define what we call a solar system. Can you use the image above to name all the planets in our solar system in order, starting with the planet closest to our sun?

The planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. Do you know a fun way to help you remember their names and order? Think of this sentence: My Very Educated Mother Just Served Us Nachos. The beginning letter of each word represents a planet!

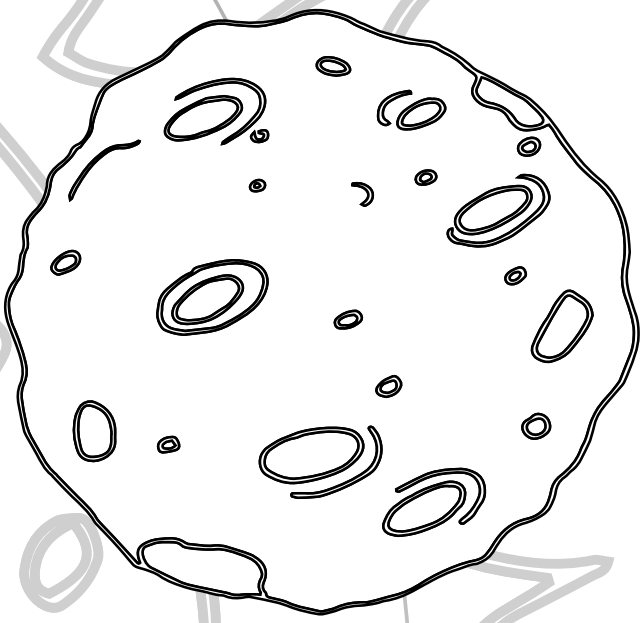
FUN SPACE FACTS

You can add the facts below and other fun facts you learn on the coloring pages that follow:

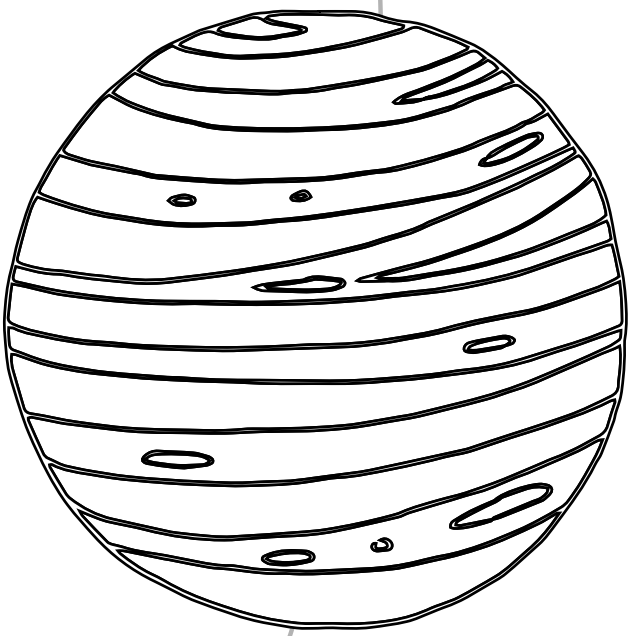
- Mercury might be the planet closest to the sun, but it isn't the hottest.
- Because of its atmosphere, Venus is the hottest planet in the solar system.
- Earth is the only planet not named after a Roman god.
- If you stood at the equator on Mars, your feet would be warm, but your head would be freezing cold.
- Jupiter has the shortest day – about 10 hours!
- If you could build a big enough bathtub, Saturn would float.
- Uranus' moons are named after characters created by William Shakespeare and Alexander Pope.
- Neptune's winds are the fastest in the solar system.

INNER

Add some favorite facts about the inner planets to the illustrations below.



Mercury



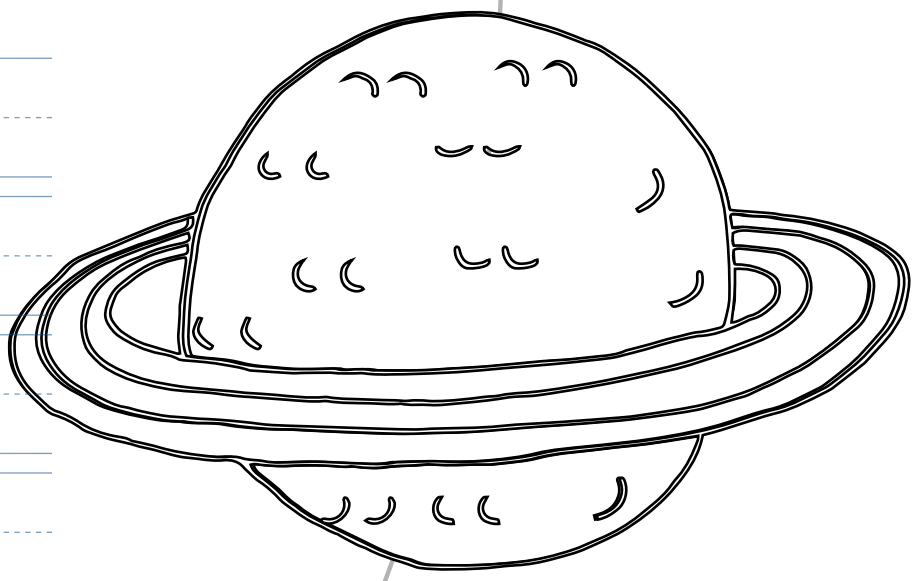
Venus

PLANETS

OUTER

Add some favorite facts about the outer planets to the illustrations below.

Jupiter



Saturn

PLANETS

Create A MODEL SOLAR SYSTEM

This is a fun activity that connects both science and math concepts in a hands-on and visual manner.

You will need:

- Balloons of all sizes and colors – Party Stores typically carry a good variety.
- Paper for stuffing – Newspaper works well.
- Plastic cups for display holders
- Paper plate
- Permanent marker
- Measuring tape

You will do:

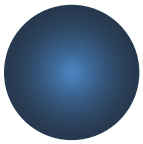
1. Select color and size of balloons for your planets.
   - Mercury – black – 1 inch
   - Venus – orange & yellow – 2.5 inches
   - Earth – blue & green – 2.75 inches
   - Mars – red – 1.75 inches
   - Jupiter – gold, red, & white – 30 inches
   - Saturn – yellow & white – 25 inches
   - Uranus – aqua & pale green – 10.75 inches
   - Neptune – dark blue & light blue – 10.25 inches

2. Roll paper to approximate diameter listed above. Wrap balloons (cut to fit) around the paper wad and apply pressure to shape your planet. You can cut holes in balloons to let other colors show through or to represent clouds.
3. Cut out the center of a paper plate and use the outside ring as a ring for Saturn.
4. Turn the plastic cups upside down, write the planet name, and use as a display.

Take It Further—Understanding Distances:

If the sun was smaller than a dime, the following distances would be a good representation of planetary distances. Cut out the image here and set it down in a large open area. Then measure off these steps and set your planets in place.

- Sun - edge of the area
- Mercury - 1 step from the sun
- Venus - 2 steps from the sun
- Earth - 2.5 steps from the sun
- Mars - 4 steps from the sun
- Jupiter - 13 steps from the sun
- Saturn - 24 steps from the sun
- Uranus - 49 steps from the sun
- Neptune - 76 steps from the sun

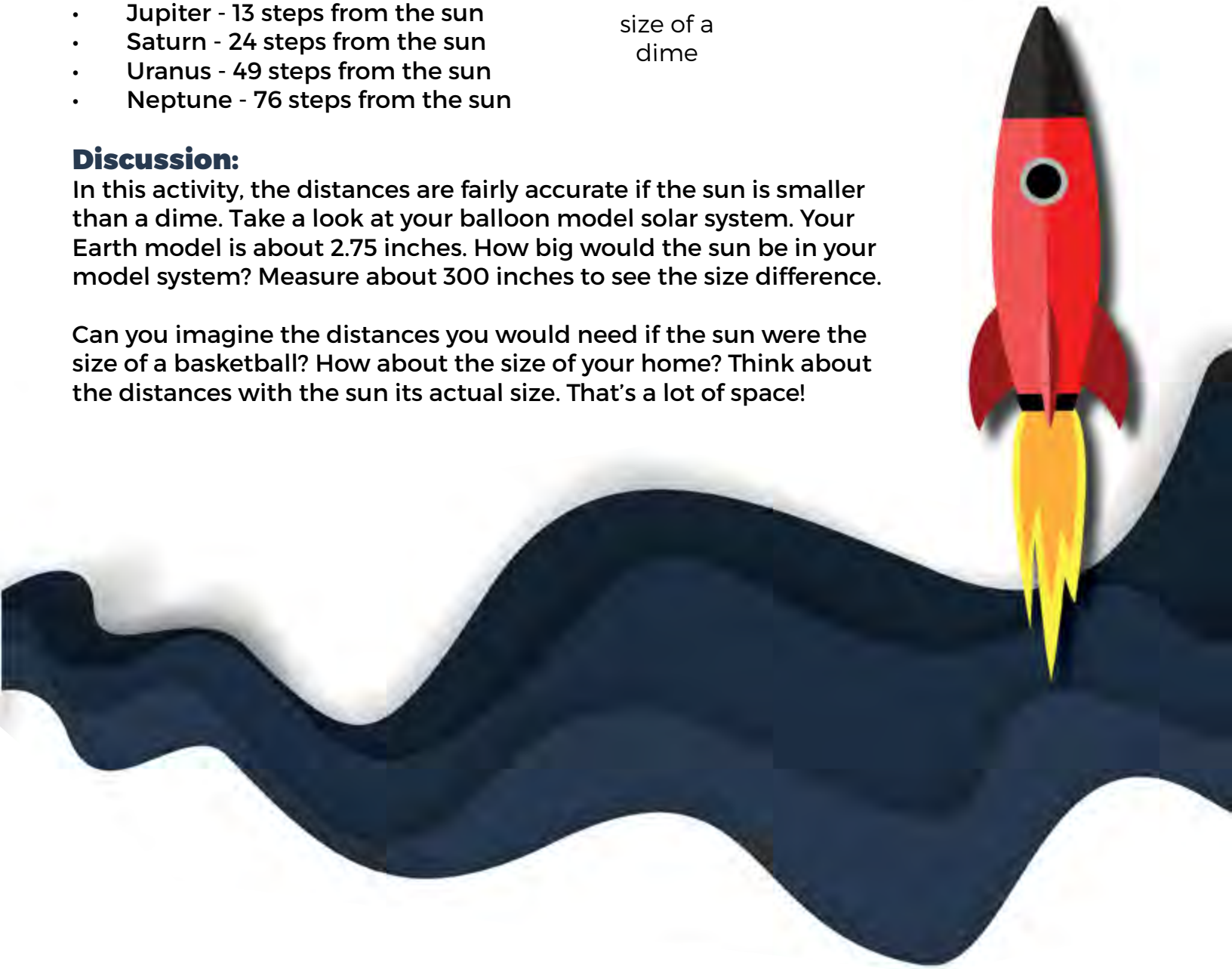


size of a dime

Discussion:

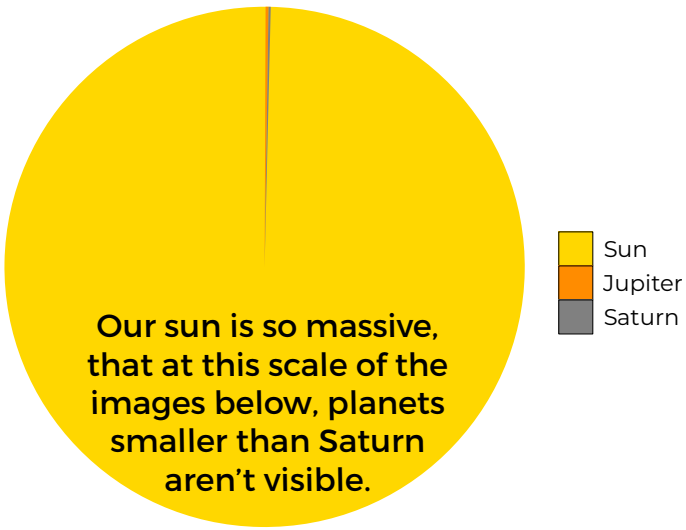
In this activity, the distances are fairly accurate if the sun is smaller than a dime. Take a look at your balloon model solar system. Your Earth model is about 2.75 inches. How big would the sun be in your model system? Measure about 300 inches to see the size difference.

Can you imagine the distances you would need if the sun were the size of a basketball? How about the size of your home? Think about the distances with the sun its actual size. That's a lot of space!



Just HOW BIG IS OUR SUN

Did you know that our sun is so massive that it comprises most of the total mass of our solar system?



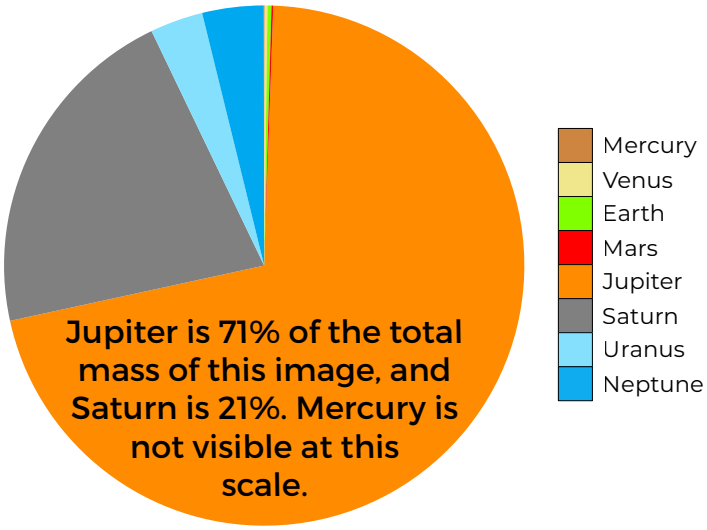
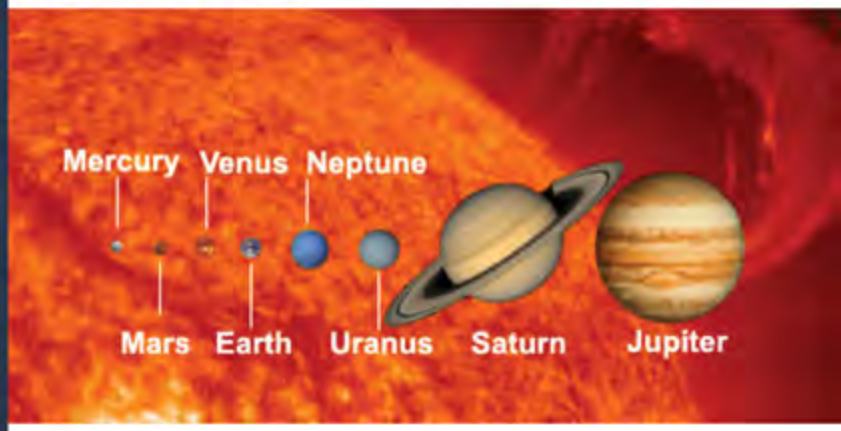


Image credit: Das steinerne Herz, translation by Szczureq / CC BY-SA (https://creativecommons.org/licenses/by-sa/3.0)

Think About This

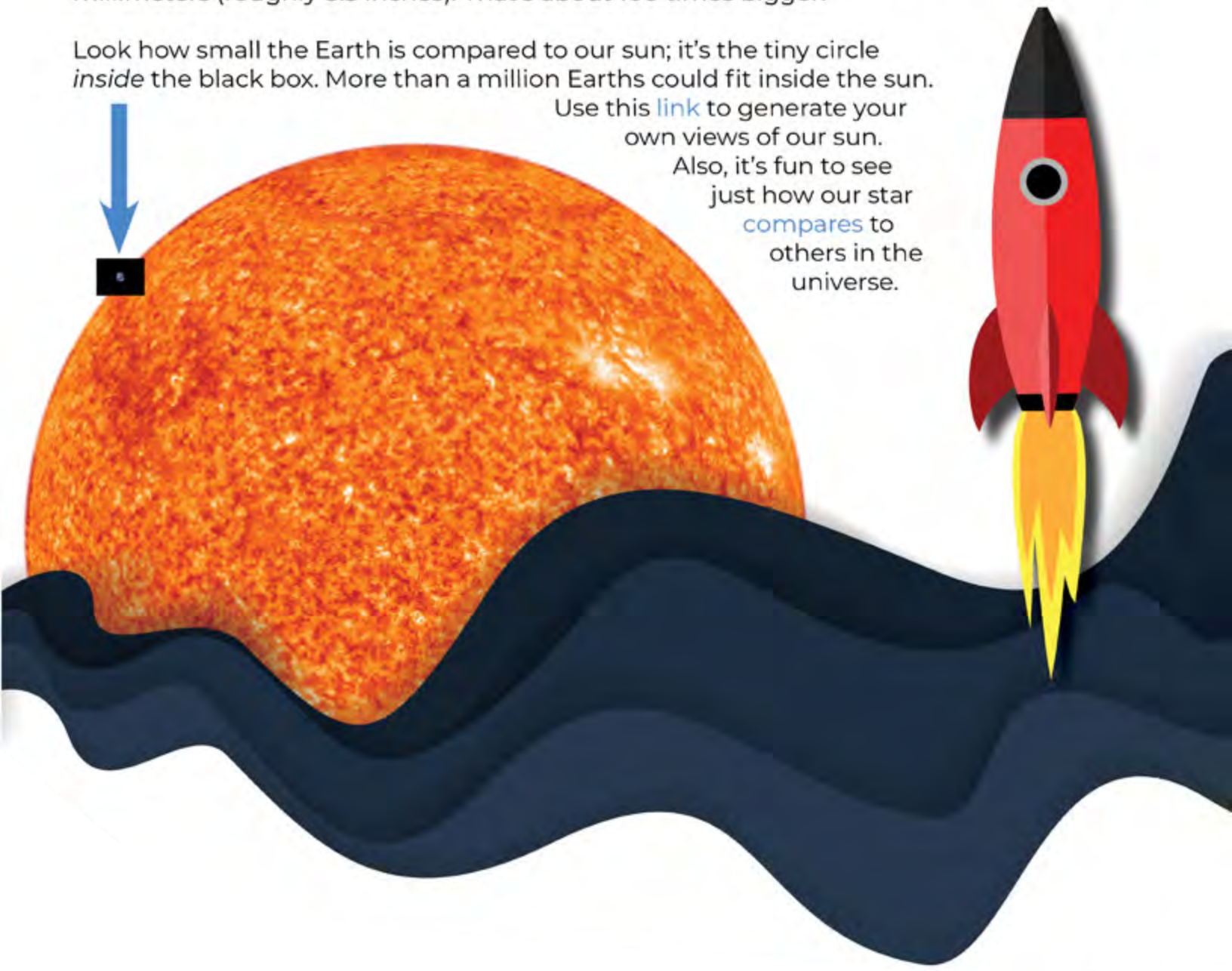
"When you sum up the mass of everything in the solar system: the sun, all the planets, dwarf planets, moons, asteroids, comets, Kuiper belt objects, Oort cloud objects, and dust... the sun accounts for 99.86% of it. That leaves only 0.14% left for everything else - and MOST of that is Jupiter!"
– Bob Trembley



This picture shows how big our sun is compared to the planets in our solar system. If the Earth is represented as about 2 millimeters across, the sun would be about 218 millimeters (roughly 8.5 inches). That's about 100 times bigger!

Look how small the Earth is compared to our sun; it's the tiny circle *inside* the black box. More than a million Earths could fit inside the sun.

Use this link to generate your own views of our sun. Also, it's fun to see just how our star compares to others in the universe.



Our sun is big, bright, and full of energy. It's been estimated that our sun makes more energy in one second than all the energy the world has used since it began. Think about it. That's a lot of energy. Learn all about the energy from our sun in this good NASA video. The energy inside the sun comes from a process called nuclear fusion. You might enjoy playing this Fusion game to keep the sun burning bright.

Illustration from Apologia's Exploring Creation with Astronomy 2nd Edition

Create a RAINBOW MAKER

What color is light from the sun? You might think that light is invisible. The color of the sun's light, however, contains all the colors of the rainbow! So, the sun's light is red, orange, yellow, green, blue, indigo, and violet. All those colors found in the sun's light make every single color in the whole world, so we have a very colorful sun. In this activity, you are going to see invisible light turn into all the colors of the rainbow.

You will need:

- CD*
- Glue
- Tape
- Scissors
- Notecard
- Markers

You will do:

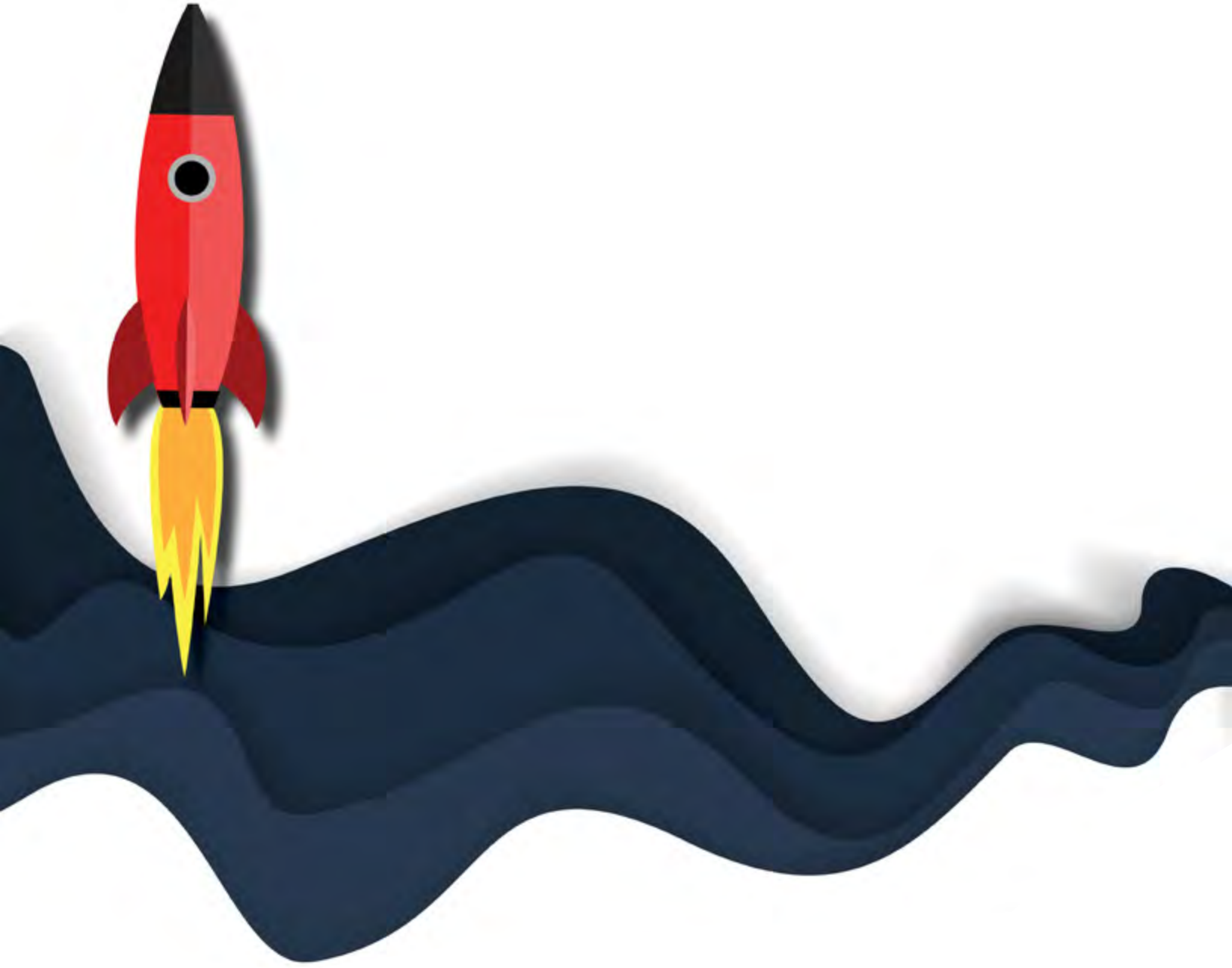
1. Cut the CD in half.
2. Glue the two halves together so that the reflective side faces out on both sides.
3. Fold your notecard to make a stand for your rainbow maker. You can use your markers to decorate your notecard.
4. Use your tape to secure your rainbow maker in your notecard stand.
5. Place your rainbow maker in a sunny spot and position it such that it projects rainbows about your room.

Discussion:

You can separate all the colors in the sun's light by using a prism. In this activity, the grooves on the CD surface act as a prism separating out the different waves of the sun's light. In a real rainbow, the raindrops in the air act as little prisms. Save your rainbow maker for the next activity.

*If you do not have a CD, there are other ways you can create a rainbow:

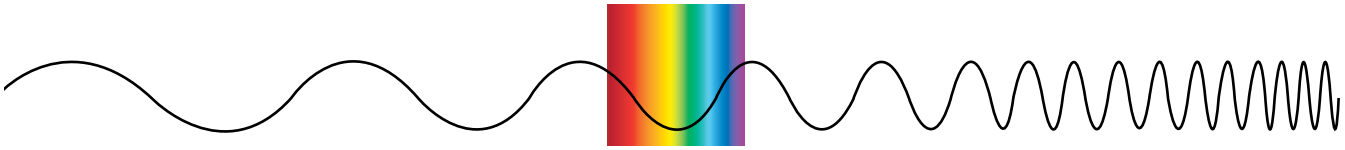
- If you have a prism, you can place it in the sunlight to see the rainbow.
- If you don't have a prism, you can make one using a clear glass of water. Fill the clear glass with water and place it in the sunlight to see the rainbow.



The TEMPERATURE OF THE RAINBOW

Did you know that the energy coming from the sun has much more than just the colors of the rainbow in it? You are going to do several activities to understand not only the visible rainbow, but also even more of what is found in the sun's light. In the image below, you can see that the rainbow of colors makes up only a small part of the light coming from the sun. Let's explore all aspects of these fascinating facts.

THE ELECTROMAGNETIC SPECTRUM (Wavelength in Meters)



Radio	Microwave	Infrared	VISIBLE	Ultraviolet	X-ray	Gamma Ray
← 1	1 to 10^{-3}	10^{-3} to 10^{-4}	8×10^{-7} to 4×10^{-7}	3×10^{-7} to 10^{-8}	10^{-8} to 10^{-12}	10^{-12} →

Do you use a microwave, radio, cell phone, or television? These objects use at least one form of electromagnetic waves. Manmade objects use electromagnetic waves to function, but the sun and other objects in the universe also emit electromagnetic radiation. To understand the electromagnetic spectrum, we will first define electromagnetic radiation. Let's start with the term electromagnetic. Electromagnetic is another word for light. Stars, planets, and the sun all have magnetic fields. In fact, all objects with a temperature above absolute zero (the temperature where atoms would stop moving) radiate electromagnetic radiation.

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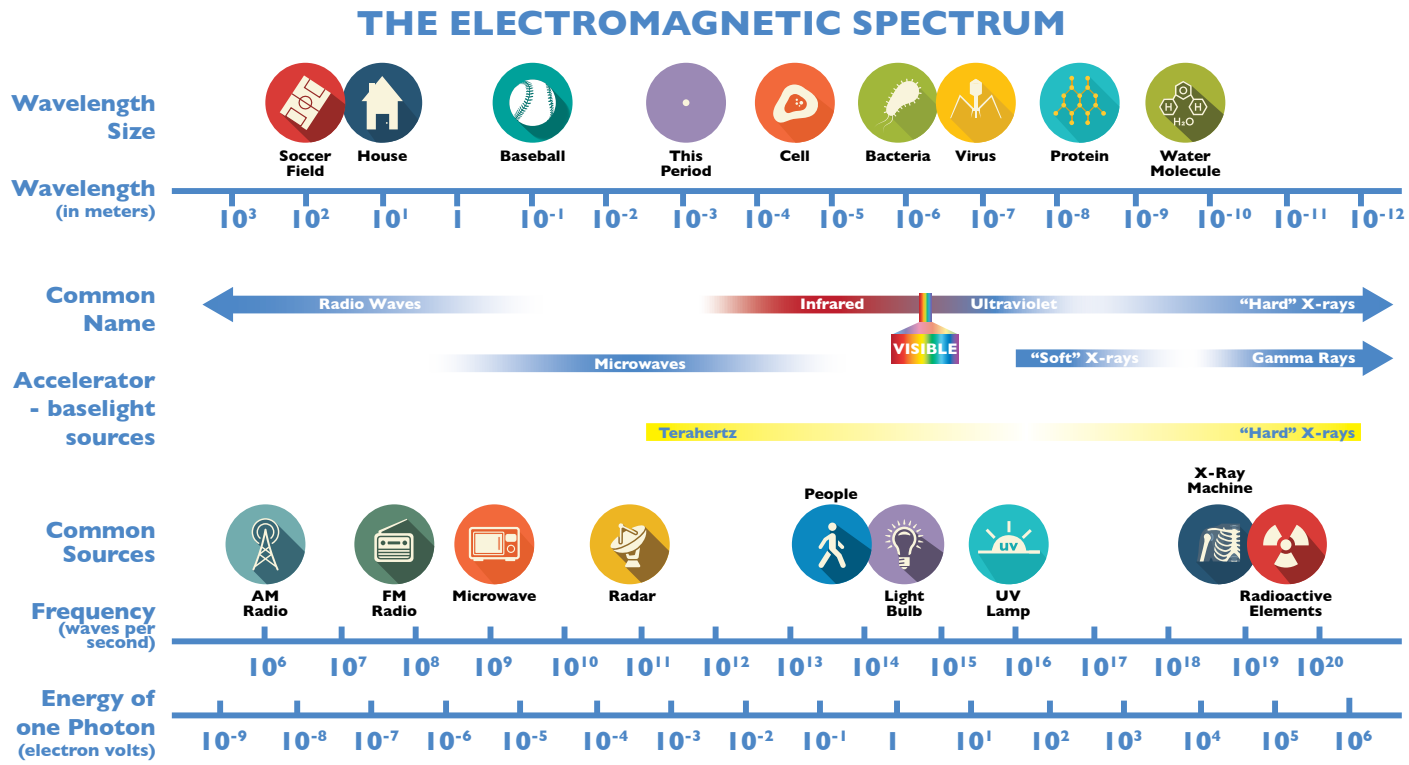
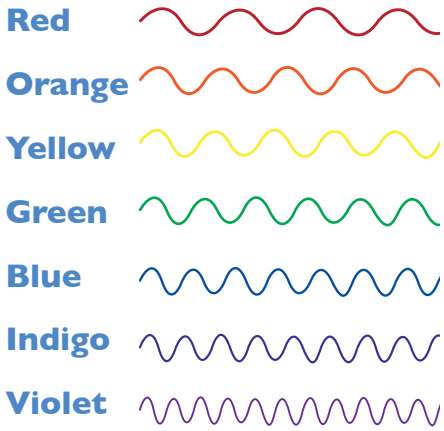


Find the visible light section. This is the part of the electromagnetic spectrum that we can see using our unaided eyes. When you look at the illustration, you will see that we can only use our eyes to detect very little of the electromagnetic spectrum. That does not mean that it does not exist. Remember that the light from the sun looks invisible to us until we split it out into its colors.

Sometimes you might hear the term white light instead of visible light. The light we see with our eyes does have color, but we cannot see the colors until we view a rainbow in the sky or we direct the light through a prism.

Look at the diagram below. The visible (white) light enters the prism from the left. The prism then splits the white light into its wavelengths of different colors.



Each individual wavelength within the spectrum of visible light wavelengths is representative of a particular color. You may already know the mnemonic phrase ROY G BIV to help remember the color and order of the waves in the visible light spectrum: red (R), orange (O), yellow (Y), green (G), blue (B), indigo (I), violet (V). When light of that particular wavelength strikes the retina of our eye, we perceive that specific color. When all of the colors strike our retina at the same time, we perceive white — thus, the name white light.

Did you know that individual colors have unique temperatures associated with them? It's true; they do! In 1800 William Herschel devised this experiment to record the temperature of the different colors in the sun's light. His experiment also led to the discovery of infrared waves. In this activity, you will see the colors in the visible light spectrum and chart their temperatures. You will also chart the temperature of infrared light that you cannot see.

You will need:

- Your rainbow maker
- Thermometer
- White paper
- Clear sunny day
- Timer

You will do:

1. Place your rainbow maker in direct sunlight so that it creates a rainbow on your white paper.
2. Keep your thermometer out of direct sunlight for 10 minutes and then note the temperature here: _____.
3. Place the thermometer in the yellow range of the rainbow and let it sit for 10 minutes. Record the temperature in the chart.
4. Let your thermometer sit for 10 minutes with no direct light hitting it, then record your temperature here: _____.
5. Place your thermometer in the violet range of the rainbow and let it sit, recording the temperature in the chart after 10 minutes.

	Yellow Range Temperature	Violet Range Temperature
After 10 minutes		

6. Let your thermometer sit for 10 minutes with no direct light hitting it. Record the temperature here: _____.
7. Place the thermometer in the red range of the rainbow for 10 minutes and record the temperature in the next chart.
8. Let the thermometer sit in a shady spot for 10 minutes and record the temperature here: _____.
9. Place the thermometer just barely to the left of the red range of the rainbow. Record the temperature after 10 minutes.

	Red Range Temperature	Infrared Range Temperature
After 10 minutes		

You can repeat the experiment measuring temperatures in the other colors of the spectra. Be sure to record your results.

Discussion:
This activity is designed to show an increase in temperature from violet to red. When Herschel noticed an even warmer temperature measurement just beyond the red end of the visible spectrum, he had discovered infrared light!

Edible Rainbow

Serve up individual rainbow cups and tell everyone at the dinner table everything you know about the light and energy from the sun.

An assortment of Jell-O flavors was made with half the water used in a normal recipe. Half the mix of each flavor had vanilla yogurt mixed in (you can make other substitutes). The colors were then layered in clear cups with each layer taking about 15–20 minutes to gel.

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-Homeschool Mom

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USING SCIENCE and MATH to EXPLORE AND UNDERSTAND OUR Universe

We've done quite a few activities to better understand our solar system. How do scientists and mathematicians use the knowledge we have to further our understanding of our place in the universe? Well, we explore our universe through astronomy and planetary missions. Let's begin our exploration with this next activity from Apologia's new *Exploring Creation with Mathematics, Level 1*. If we're going to further explore the universe, we need to create a countdown clock!

PIPE CLEANER NUMBERS

You will need:

- Eleven pipe cleaners
- Fifty-five beads

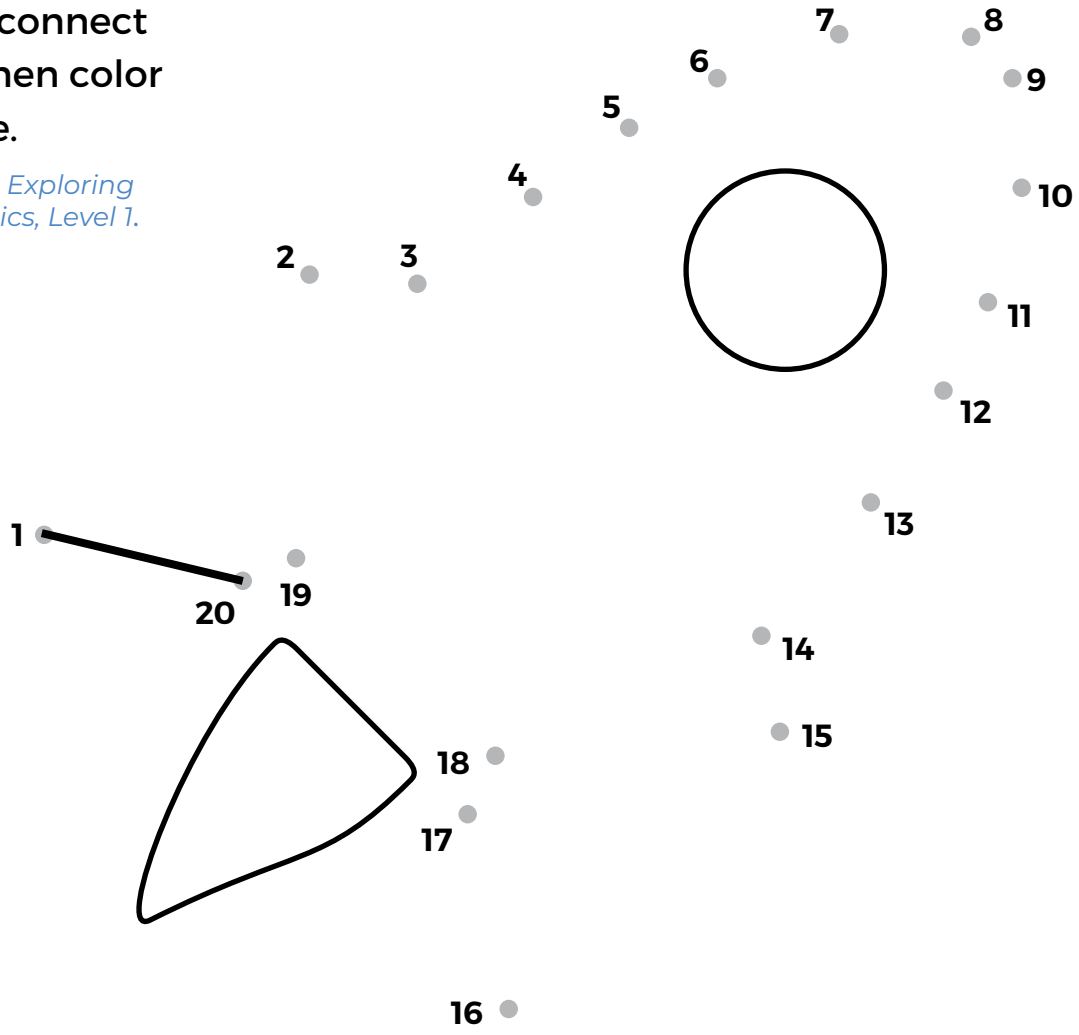
You will do:

1. String a pipe cleaner with 1 bead. String the next pipe cleaner with 2 beads and so on for nine pipe cleaners. For the numeral 10, string 5 beads on each of two pipe cleaners.
2. Bend the pipe cleaner into the shape of each one of the numbers below. For the number 10, place 5 beads on the one and 5 beads on the zero.

Once you have your numbers assembled, you can hang them on a wall (backwards from 10 to 1) and then complete the rocket image on the next page to hang next to them for lift-off!

Starting with one, connect the dots in order. Then color your picture.

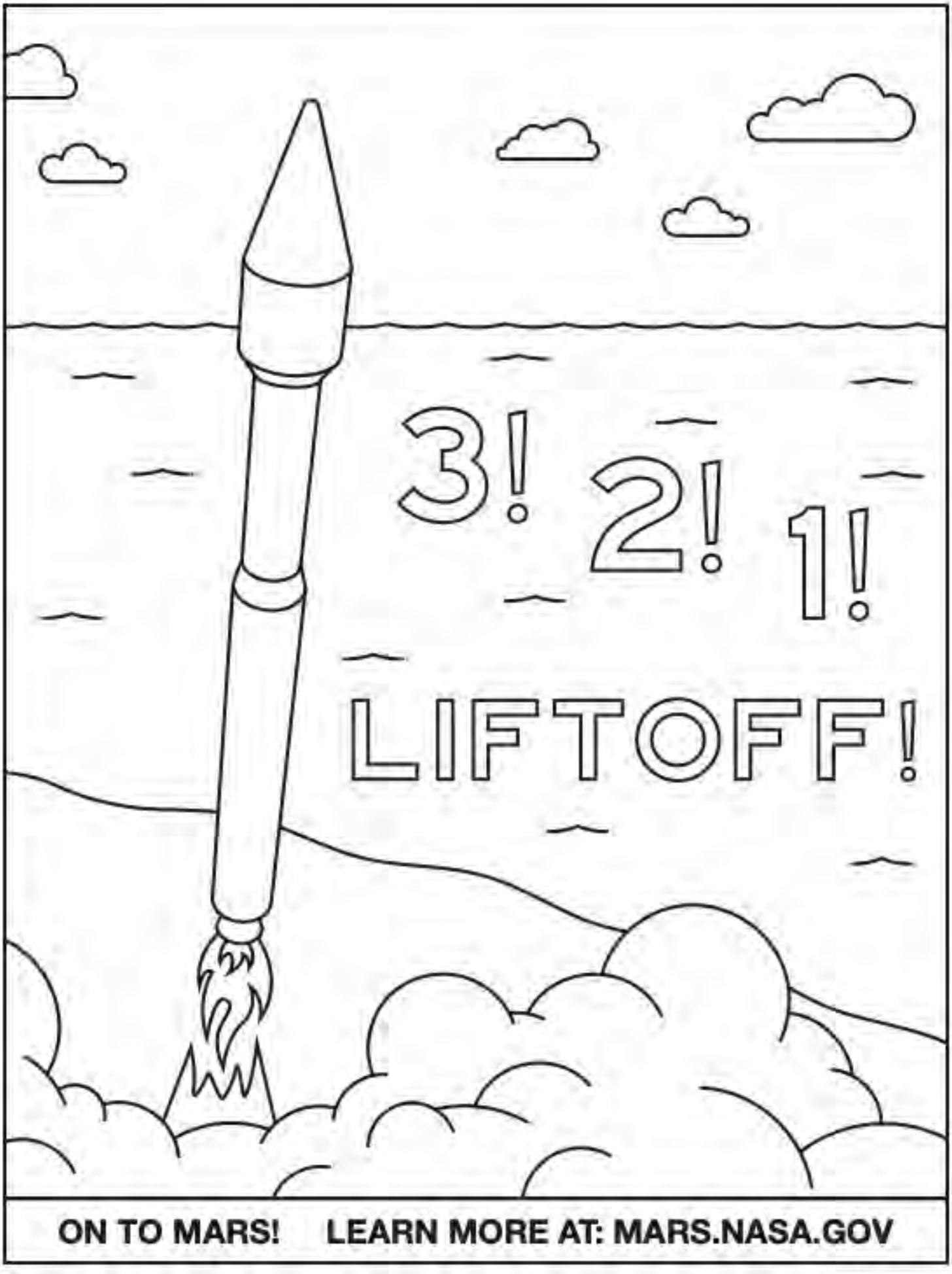
Adapted from Apologia's *Exploring Creation with Mathematics, Level 1*.



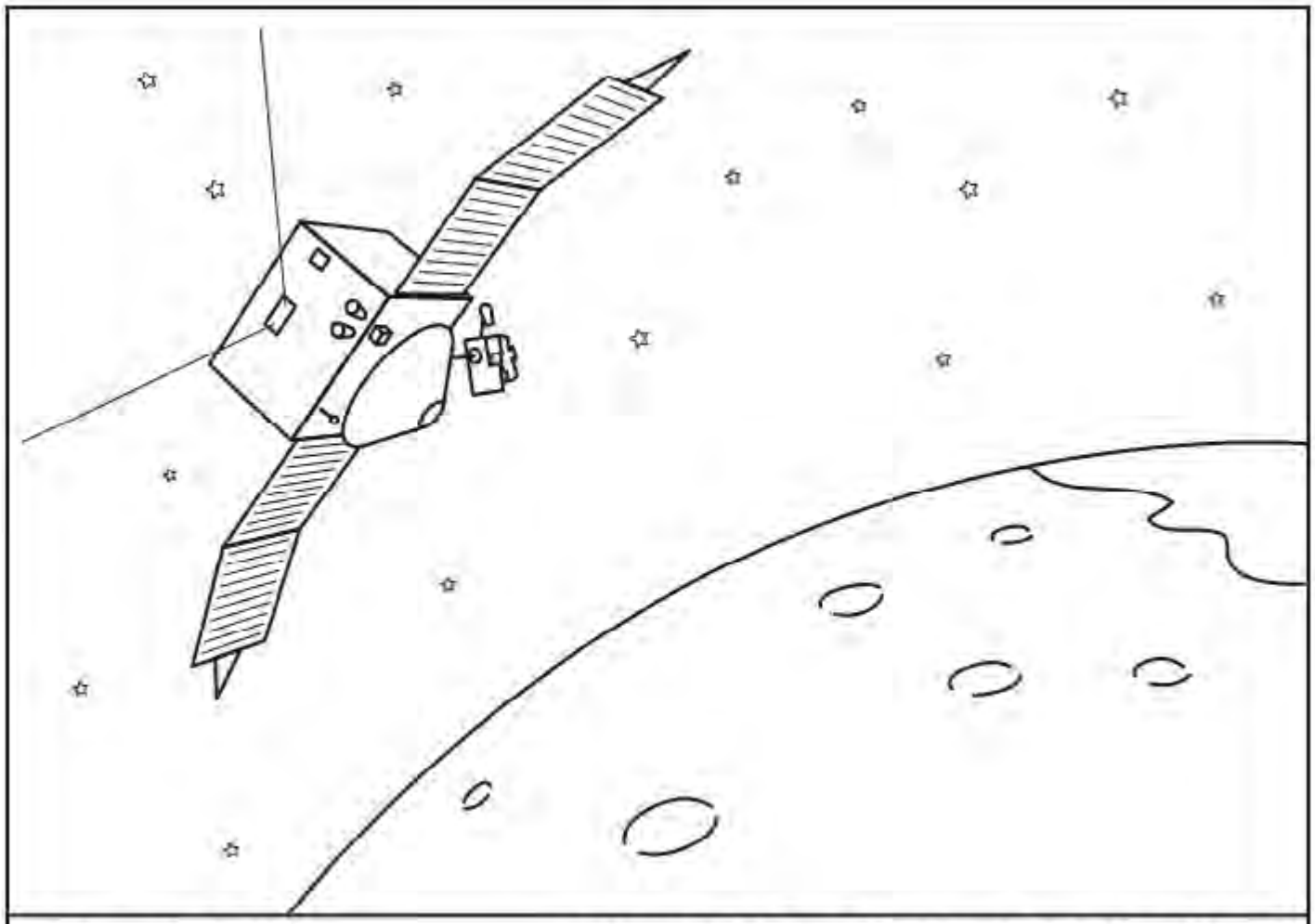
Missions of Exploration

Learning about a planet takes time—lots of time. Knowledge is gained and built upon as we advance in technology. We start with flybys in which spacecraft photograph the planet as they pass by. We expand with orbiters that orbit around the planet and gather specific information. We advance to landers and rovers that actually touch the surface of a planet and investigate the surroundings.

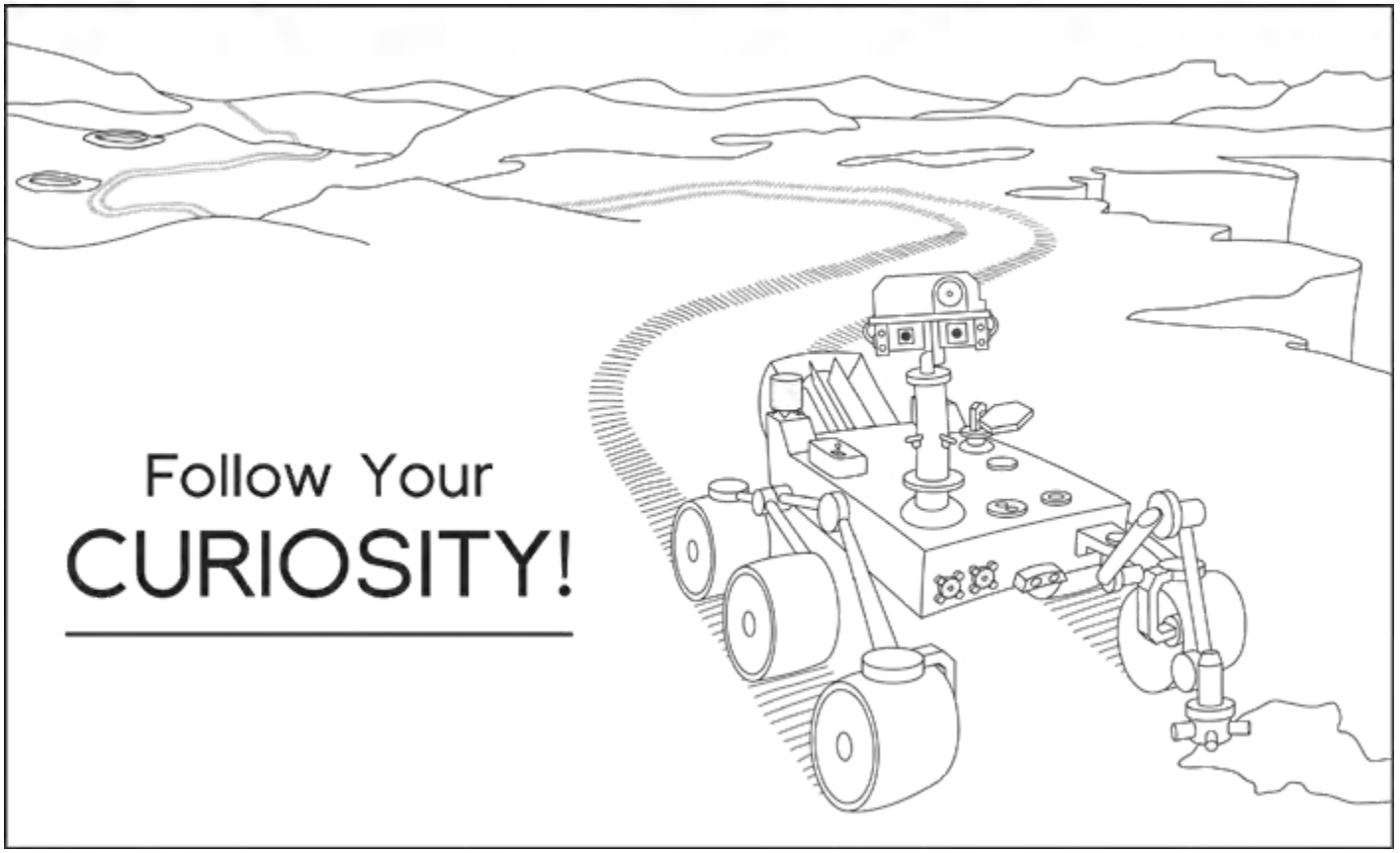
Here are some coloring pages on Missions to Mars from NASA's website for you to enjoy.



ON TO MARS! **LEARN MORE AT: MARS.NASA.GOV**

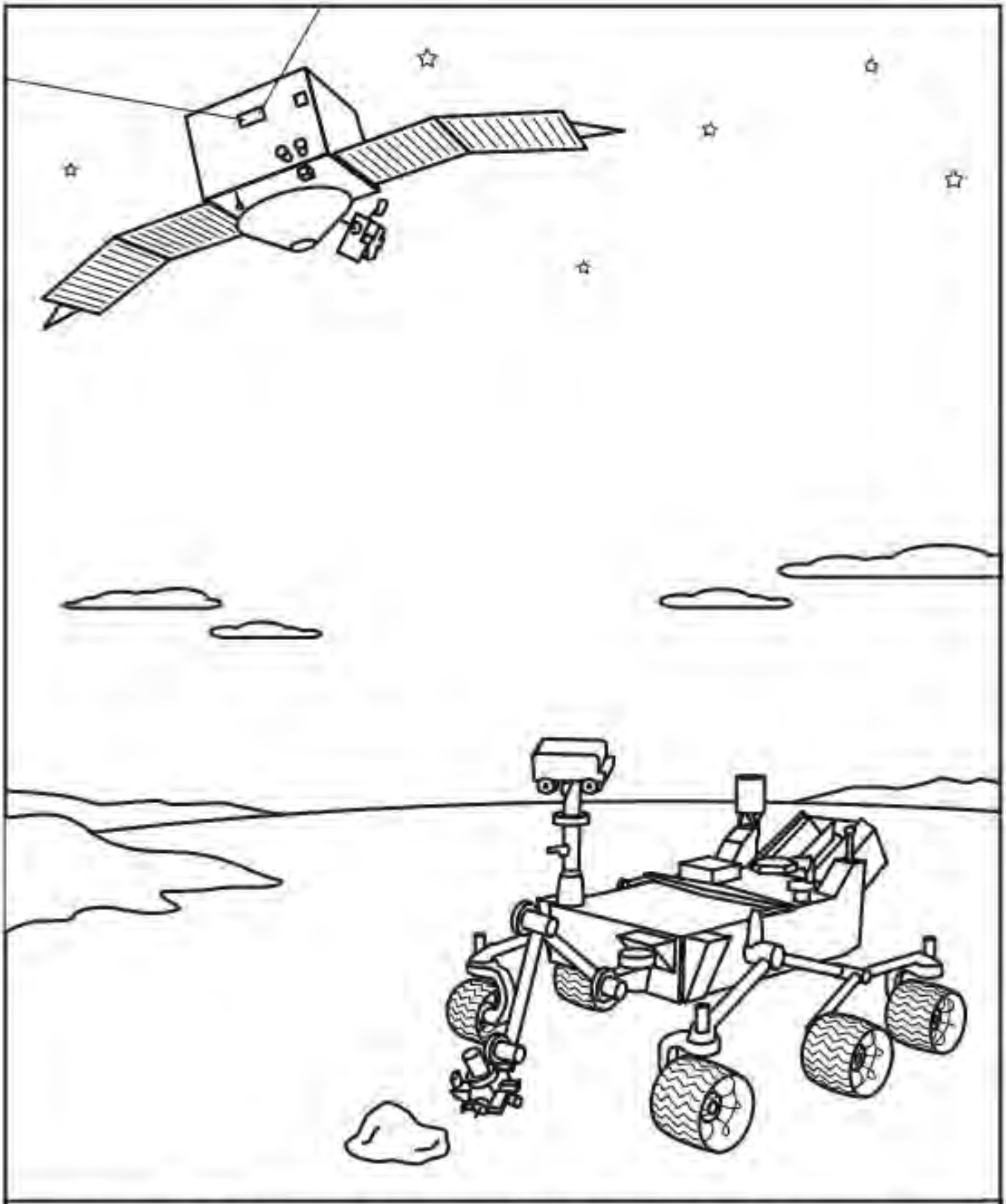


MAVEN AT MARS **LEARN MORE AT: MARS.NASA.GOV/MAVEN**



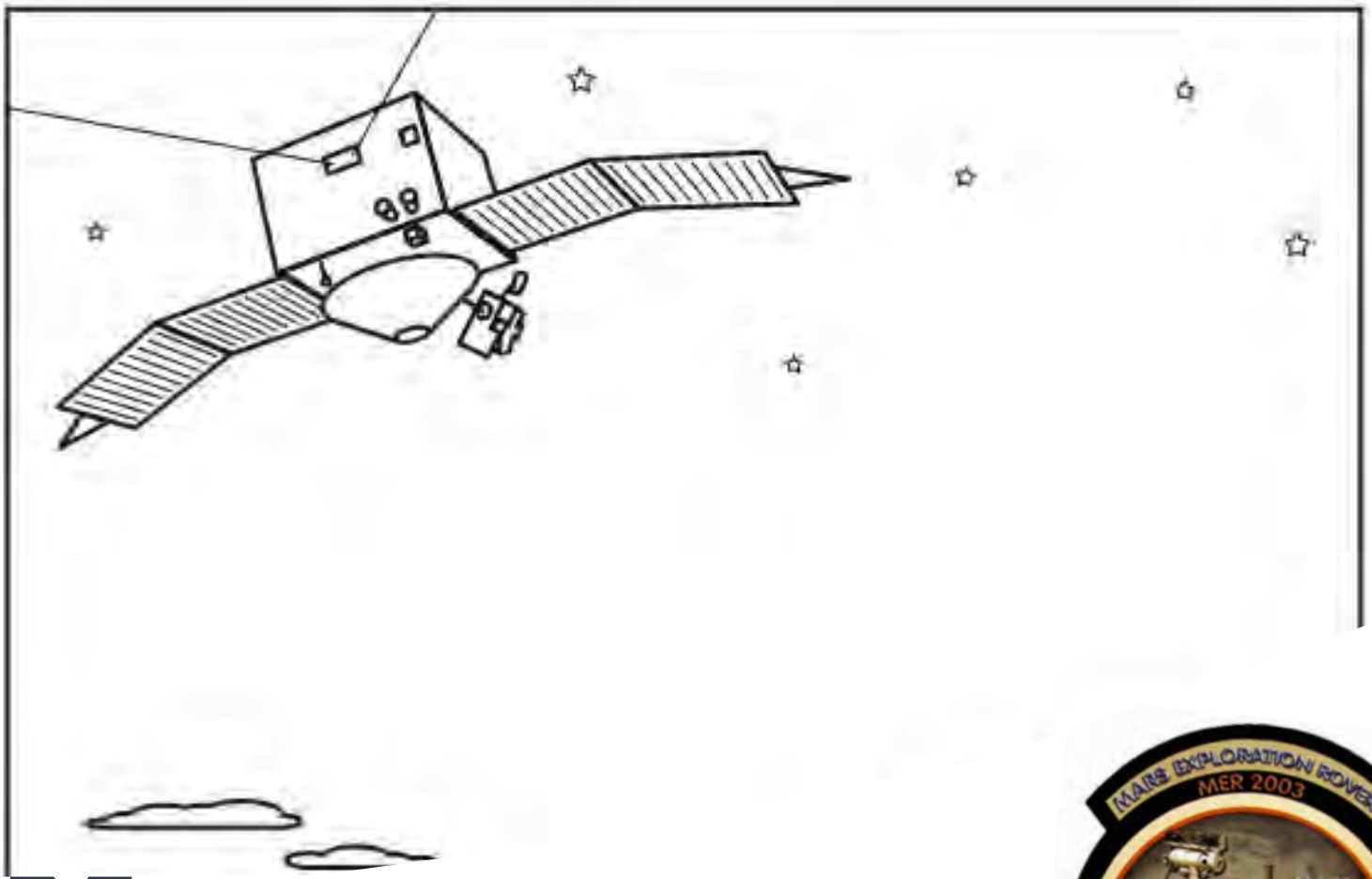
Follow Your

CURIOSITY!



MAVEN & CURIOSITY – WORKING TOGETHER!

LEARN MORE AT: MARS.NASA.GOV/MAVEN



Missions to other planets take lots of time and lots of money. Because of this, it is important that engineers and scientists do as much research as they can up front to understand their mission and create a spacecraft that can perform its duty flawlessly. You don't want your lander to tip over, bounce around a lot, or damage instruments when you land on a planet you want to explore.

You will need:

- Your imagination and craft supplies, such as cardboard, Styrofoam cups, bubble wrap, etc.

You will do:

1. Brainstorm – what task will your interplanetary craft be asked to complete? Record your ideas on page 31.
2. Research – will you need to create a new technology to complete your task?Record your ideas on page 31.
3. Come up with a mission name and emblem to use on a badge. Record your ideas in the Mission section on page 32.
4. Design – build a model of your explorer. You may need several prototypes to get it right so that it survives your testing. Record your ideas in the Mission section on page 33.
5. Get ready testing.
   a. Drop your spacecraft from about your waist height and see what happens. Does it tumble or break? That would not be good for a planetary landing.

b. Look at all the craft items you have available. How could you stabilize and cushion your spacecraft so that it could land properly? Think about ways you could add shock-absorbers (straws work well).
c. Test each idea until you can safely drop your spacecraft from your waist height, and it lands upright with all of its instruments intact.

6. Take it further – There is a reason NASA works really hard to land on flat surfaces. Drop your lander onto some bumpy pillows or create a crater and see if you can successfully complete a landing there. Record your trials on page 33.

Brainstorming!

Mission Tasks:

New Technologies the Mission Will Require:
(Describe or draw your ideas in the space below.)

Mission Name: _____

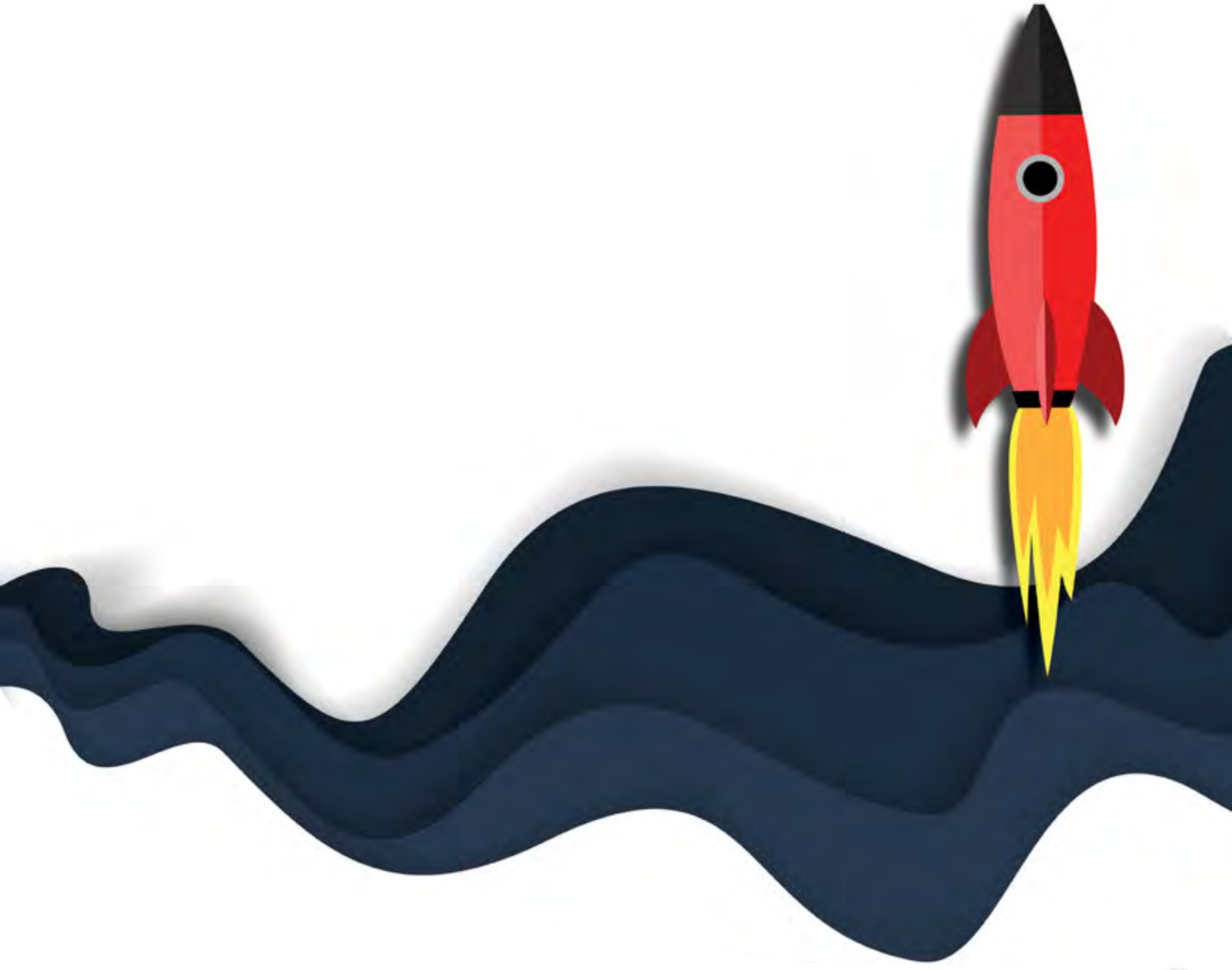
The official mission badge:

Mission DESIGN & TESTING LOG

As you adjust the design of your mission vehicle, attach a photo or draw a picture of how you adjusted the vehicle in the space below.

Take It Further!

Were you able to successfully complete your landing on a bumpy surface? Describe your landing and any adjustments you made to aid your landing.



Let's MAKE & TEST PARACHUTES

During its descent to the surface of Mars, InSight used a parachute. This graphic shows its entry, descent, and landing sequence. You can read more about the landing sequence on the NASA website.

You will need:

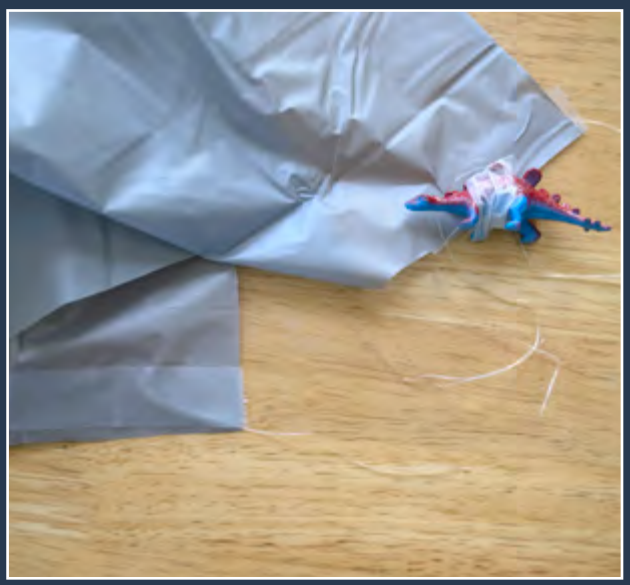
- String: cotton, nylon, clear craft cord, or other types of string to test
- Paper plate
- Piece of tissue paper
- Small plastic toys (dinosaurs, insects, etc.)
- Other items to make a parachute: plastic shopping bag, coffee filter
- A thin plastic table cloth (found in the party supply section of discount stores)
- Scissors
- Marker
- Tape
- Ruler

You will do:

1. Cut a 12” square out of the tissue paper and a 12” square out of the plastic table cloth.
2. Cut 8 12” pieces of string.
3. Use tape to attach a piece of string to the corner of each square.
4. Gather the other 4 ends of the string and attach to the plastic toy using a medium-sized piece of tape.
5. Drop your parachute from a high place. You may require adult supervision for this step.
6. Did one parachute travel further than the other? Did one parachute take longer to reach the ground than the other?

Take it Further:

1. Cut a 12” square out of the tissue paper and a 12” square out of the plastic table cloth.
2. Cut 8 12” pieces of string
3. Use a paper plate to draw a circle on the 12” tissue paper square and the 12” plastic table cloth square.
4. Imagine there is a big square drawn on your circles, attach a piece of tape to each of the four corners of this square.
5. Gather the other 4 ends of the string and attach to the plastic toy using a medium-sized piece of tape.
6. Drop your round parachutes from a high



place. You may require adult supervision for this step.

7. Did one parachute travel further than the other? Did one parachute take longer to reach the ground than the other?
8. Now drop your square plastic parachute and then your round plastic parachute? How do they compare?
9. Drop your square tissue paper parachute and then your square plastic parachute? How do they compare?
10. Using a coffee filter, make a parachute by attaching 4 12" pieces of string and attaching a plastic toy. How does this coffee filter parachute compare to the others?
11. Use a plastic shopping bag and string to make a parachute. How does it perform compared to the other parachutes?
12. Test different sizes and weights of plastic toys.
13. Test different types of string.

CONCLUSIONS:

My tests show that the _____

parachute worked best.

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You've successfully built and tested a spacecraft to explore another planet, but you still have to get it there. That isn't as easy as you think! The first step is having a rocket that can carry your spacecraft where it needs to be. Let's do some experiments with rocket science.

Rocket Science

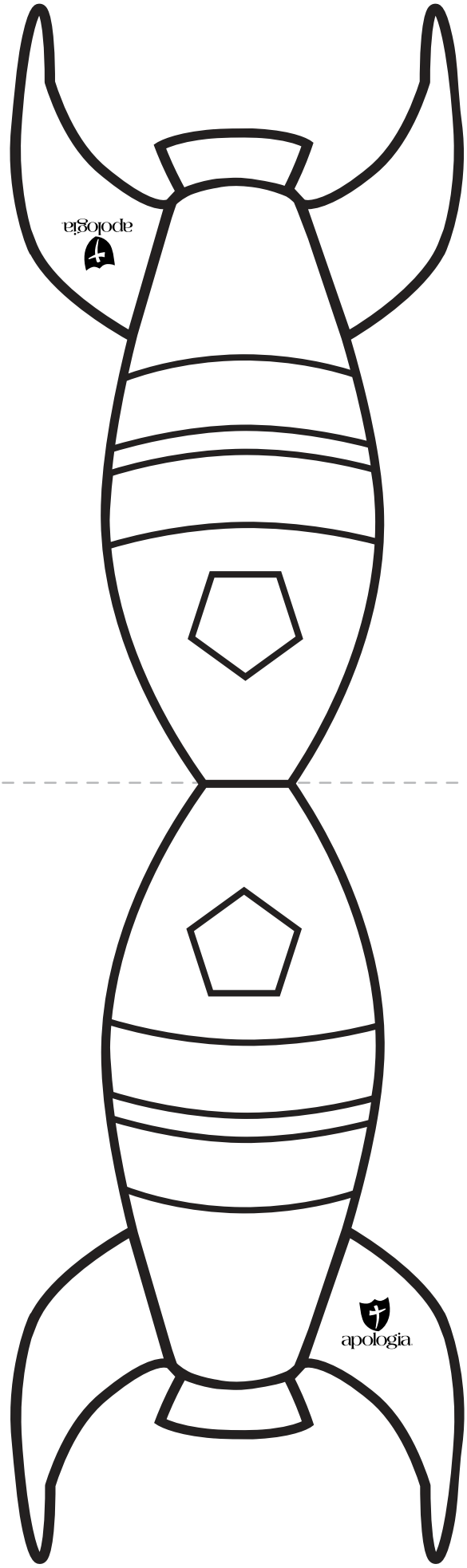
You Will Need:

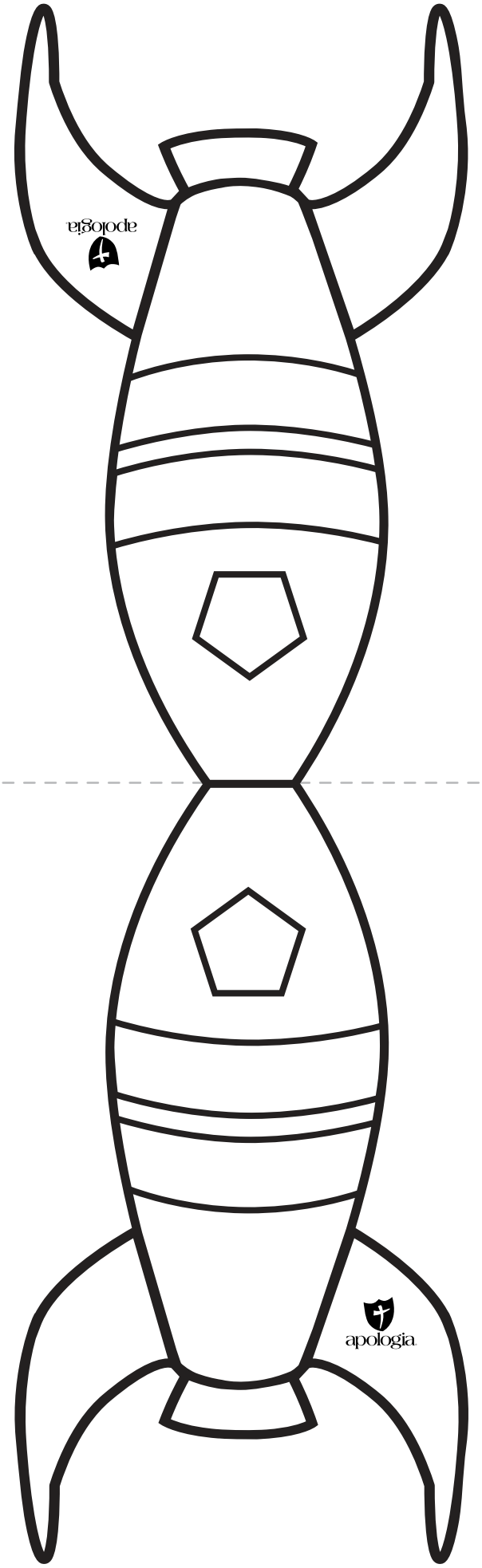
- Crayons
- Rocket template (page 40)
- Tape
- Ruler
- Straw
- Pen
- Scissors
- 2 Pennies

You Will Do:

1. Print template on card stock
2. Cut around both sides of the rocket. Do not cut the solid line at the top of the rockets. This is the fold line.
3. Fold the rocket on the fold line.
4. Tape the sides and around the "fins", leave a hole open at the bottom of the rocket.
5. Cut a 5" piece of straw.
6. Place the straw partially up the center of the rocket.
7. Blow through the straw and launch your rocket!
8. Measure how far it travels and record your results.
9. Tape a penny onto your rocket.
10. Launch your rocket again, measure how far it travels, and record your results.
11. Tape a second penny onto your rocket.
12. Launch it again, see how far it travels, and record your results.
13. Can you think of any other alterations that you can make to your rocket and test to see if you can get it to go farther? Try them.

My Rocket	Distance Measured
1 penny	
2 penny	
3 pennies	
other ideas	





GETTING Ready to LAUNCH

Ok, you've built your spacecraft and have some solid rocket science behind you, but there are still a few more things you need to contemplate before you can get to your planet. The first one is that we live on a planet that rotates every 24 hours. In addition to this, it is revolving around our sun. We are constantly moving!

Activity on the Earth's Rotation

The Earth revolves around the sun as it rotates.

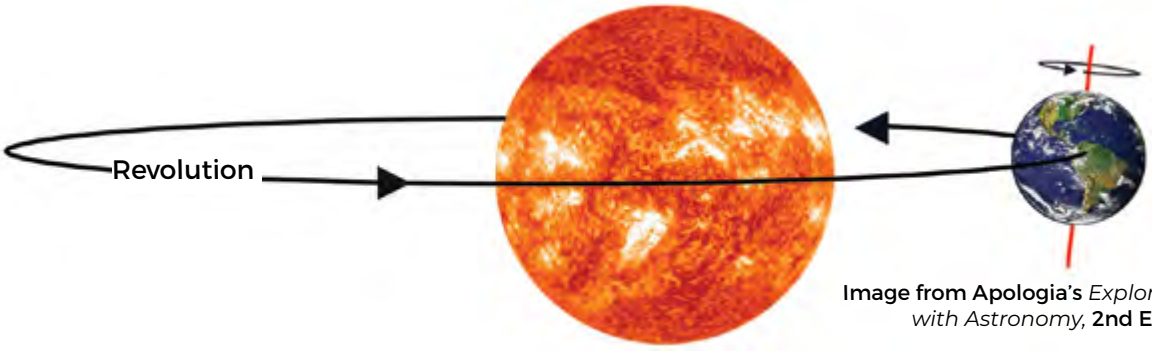


Image from Apologia's *Exploring Creation with Astronomy*, 2nd Edition.

It's hard to comprehend that the Earth is spinning at a rate of about 1,000 mph at the equator. This fun activity will help you detect that motion.

You will need:

- A sunny day
- Chalk
- Large, flat surface that is in continual sun
- Friend

You will do:

1. Find a sunny flat spot where you can see your shadow.
2. Have your friend trace around your shoes to mark exactly where you stand.
3. Cast a fun shadow and have your friend trace the outline of your shadow.
4. Wait for an hour and come back to your exact foot tracings. Is your shadow the same now as before? Trace another shadow and repeat to see the changes that happen over time. While it might seem that the sun is moving across the sky, it is really us moving. As the Earth rotates, the sun "moves" across the sky.

Discussion:

What does this all mean for a successful launch? Well, you now know that our planet is moving really, really fast. We can't just point a rocket at the sky, launch, and expect to get to a planet far, far away - which is also rotating and revolving around the sun. For a fun playground activity, visit this NASA site on launching rockets from a spinning planet! If you don't live near a playground that has a merry-go-round that you can push and then hop on and ride, you can adapt the activity to do at home.

- Securely attach a long string to a ball, like a tennis ball.
- Go outside, stand in place a safe distance from other objects, and use the string to swirl the ball above your head to simulate a spinning planet.
- See if you can let go of the string and have the ball land in a targeted zone
- Was it harder than you anticipated?

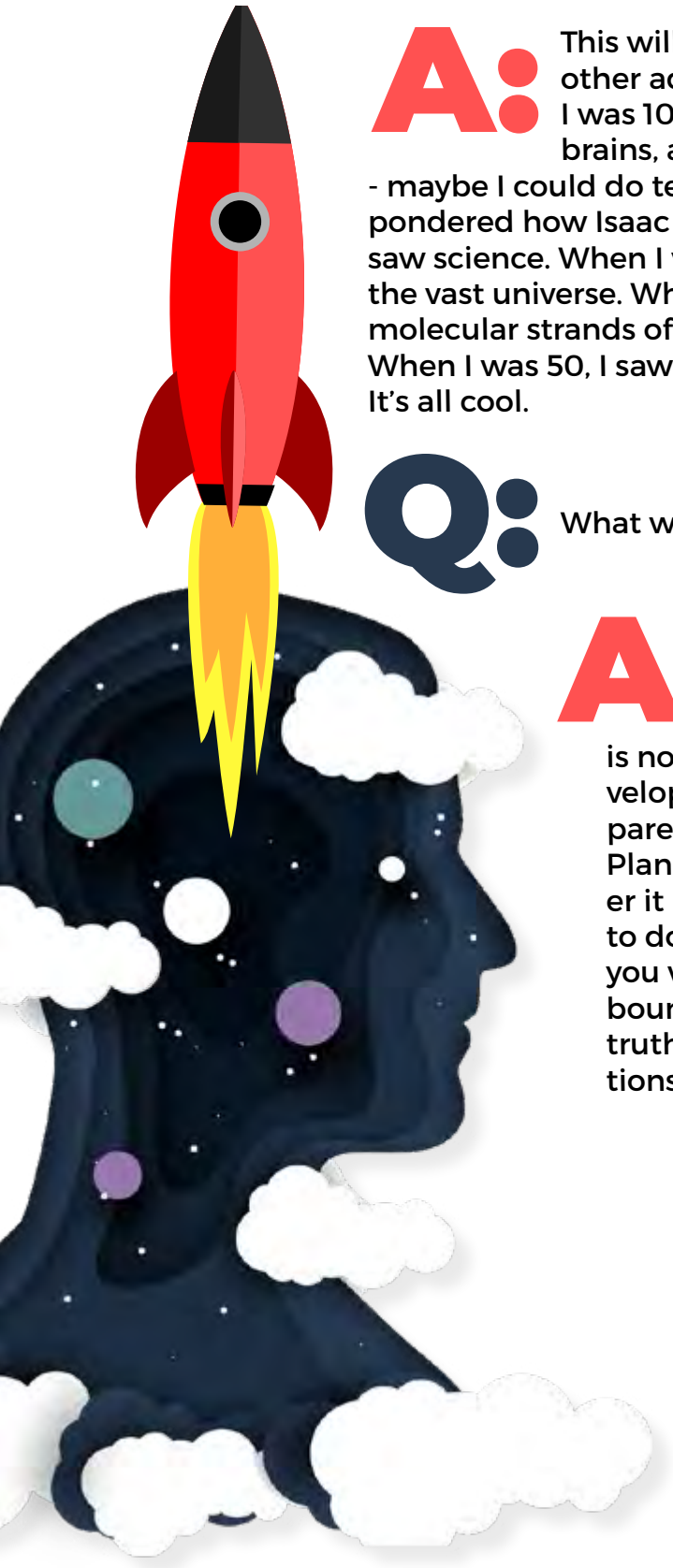
Scientists and mathematicians work together to build, launch, and land spacecraft on other planets. Maybe one day you'll be a scientist or mathematician. Or maybe, you'll be an astronaut traveling to a distant planet to explore creation in even more detail!

INTERVIEW with a NASA Engineer

Dr. Sam Yunis has worked on space structure for over 20 years as a NASA engineer, specializing in spacecraft, rocket vibrations, and acoustics. During his career, he has been a part of over 50 spacecraft and 10 different launch vehicles. He had key roles in the analysis and testing of the Cassini mission to Saturn, the Mars Reconnaissance Orbiter, the Pluto New Horizons mission, the STEREO mission to study the sun, the International Space Station, and the Ares 1-X launch vehicle. His favorite memory is being shaken in a centrifuge to better understand human performance during launch. He is currently working with commercial partners to achieve a new US manned capability. I asked Sam what he does at NASA and why:

A: In general, I work on rocket vibrations to make sure that rockets are designed to survive the controlled explosion that is a rocket launch. I started doing this because I wanted to be on forefront of technology, advancing things rather than just using things. I was very young and naive when I thought that, but it turned out to be a fantastic approach to a career.

Q: What's the coolest thing you've ever seen, contemplated, or experienced in science?



A: This will sound cliché, but every day I am wowed by another advancement in science. How can I compare? When I was 10, someone told me that we only use 8% of our brains, and I spent hours trying to activate the other 92% - maybe I could do telekinesis (like a Star Wars Jedi). When I was 20, I pondered how Isaac Newton took millennia of dropping apples and saw science. When I was 30, I saw Hubble Space Telescope pictures of the vast universe. When I was 40, I heard that scientists were making molecular strands of carbon into the mythical material unobtainium. When I was 50, I saw artificial intelligence that could out think humans. It's all cool.

Q: What would you have young people contemplate?

A: As a homeschooling dad and speaker, and a mentor at the office, I continuously ask young people to understand that the world is not static, but rapidly changing under human development. If you don't understand that, listen to your parents talk about what when they it was like grew up. Plan to live in a future world, not today's. Take whatever it is you like to do and figure out how you are going to do that in an ever-increasingly automated world. If you want to push the boundaries, don't look at today's boundaries, but the boundaries of the future. If you seek truth and guidance, then it is time to look in all directions.

Launch DAY—
WEATHER

WONDROUS WEATHER

(Adapted from *Exploring Creation with Mathematics, Level 1*)

Images licensed from GettyImages.com

Did you know that weather is very important when a rocket is launched into outer space? It's true. Scientists, engineers, and meteorologists watch the weather very closely, and if the weather isn't just right, the rocket launch is delayed. In fact, weather is the number one reason that rocket launches are delayed! A launch might be delayed for minutes, hours, or even days. There are 3 main weather conditions that can stop a launch. What do you think they might be?

THUNDERSTORMS

Rockets sitting on a launch pad are protected from the lightning because scientists have figured out a way to make lightning avoid certain objects by using tools called lightning rods. But once a rocket lifts off, it is at risk of getting struck by lightning. Rockets have lots of important electronic devices in them. If lightning strikes the rocket, these systems could be ruined, and the mission would be at an end before it even started. So, watching the weather at the site of the launch and the areas where the rocket is going to pass on its way to outer space is very critical to a successful launch.

CLOUDS AND RAIN

Rockets are very strong and powerful. Why might clouds and rain be able to stop a launch? There are a couple of reasons that these might delay a rocket launch. The first one is again related to lightning. There may not be any lightning happening at the ground level where the rocket waits, but up in the clouds, lightning could still happen. Also, it can be a lot colder inside a cloud. Moisture and temperature can affect the rocket, so clouds and rain can delay a launch.

WIND

Have you ever been outside on a really windy day? Sometimes you have to lean into the wind to even take a few steps forward! Well, high wind speeds near the ground or higher up in the atmosphere can delay a launch. Rocket direction is tightly controlled, and a big gust of wind or sudden changes of wind speed can cause a problem.

Subtraction Board Game

(Adapted from *Exploring Creation with Mathematics, Level 1*)

You Will Need:

- Two or more players
- A game piece for each player
- A die

You will do:

1. Print out the game board on page 49.
2. Player One rolls the die and keeps that number in mind while looking on the board for the nearest fact ahead that matches the number on the die. This way of playing takes a little bit of getting used to because the number on the die is the answer, not the question.
3. If Player One doesn't go to the fact closest to his or her game piece, another player can challenge and point out a closer fact. If the second player is correct, Player One must move back to the closer fact.
4. Players take turns rolling and moving forward to the closest fact.
5. When a player is on the last 6 spaces, he or she can choose to use the roll to cross the finish rather than landing on the closest fact. Players need an exact roll to land on the finish. If they do not roll the exact amount, their turn is skipped.
6. The first player to cross the finish wins the game.

Rachael Yunis is the Science and Math Director at Apologia. She has advanced degrees in molecular genetics and developmental biology and biomedical ethics, over 10 years' experience in molecular genetic research, and publications in multiple peer-reviewed scientific journals. Rachael is author of *Exploring Creation with Earth Science* and co-author of the Apologia textbook, *Exploring Creation with Advanced Biology*, 2nd edition.

She has worked as an ethicist and science writer for the American Medical Association, the Alzheimer's Association, and other national publications such as Association News. Rachael also speaks on science, ethics, and homeschooling topics. She has been a volunteer member of local hospital ethics committees, is an on-call foster parent to infants waiting to be adopted into their forever families, and works globally to support orphaned children. Rachael and her husband, Sam, a NASA engineer with a Ph.D. in mechanical and aerospace engineering, have always homeschooled their children and been active in their Virginia homeschool community.

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