Investigate the Possibilities

Elementary Astronomy

THE UNIVERSE

From Comets to Constellations

Teacher's Guide

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Unless otherwise noted, Scripture quotations are from the New International Version of the Bible.

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Unless they have access to good telescopes, students may miss some of the most exciting parts of astronomy. Fortunately, there are several ways to take advantage of some of the new information about space. For example, NASA provides a wealth of information and photographs about space science that is available to students.

There are also a number of versions of the investigations in this book that can be seen on YouTube and other sites. Both teachers and students can be involved in searching for related investigations. Be sure to keep a record of helpful videos and websites that have been located. As you look for information, be aware that many Internet sites place a heavy emphasis on how the universe evolved over billions of years. The recommended references given in this book are excellent sources of information.

Look for ways to let students view the night sky with a good telescope. You might plan a trip around a visit to a nearby university or museum where telescope viewing if available. Watch the news for meteor showers, eclipses, and other unusual events in the sky. You might even consider investing in a telescope.

1. Think about This

The purpose of this section is to introduce something that will spark an interest in the upcoming investigation. Lesson beginnings are a good time to let students make observations on their own; for a demonstration by the teacher; or to include any other kind of engaging introduction that causes the students to want to get answers. Teachers should wait until after students have had an opportunity to do the investigation before answering too many questions. Ideally, lesson beginnings should stimulate the students' curiosity and make them want to know more. Lesson beginnings are also a good time for students to recall what they already know about the lesson topic. Making a connection to prior knowledge makes learning new ideas easier.

2. The Investigative Problem

This section brings a focus to the activity students are about to investigate and states the objectives of the lesson. Students should be encouraged throughout the investigation to ask questions about the things they want to know. It is the students' questions that connect with the students' natural curiosity and makes them want to learn more. Teachers should stress to students at the start of each lesson that the goal is to find possible solutions for the investigative problem.

3. Gather These Materials

All the supplies and materials that are needed for the investigation are listed. The teacher's book may contain additional information about substituting more inexpensive or easier to find materials.

4. Procedures and Observations

Instructions are given about how to do the investigation. The teacher's book may contain more specifics about the investigations. Students will write their observations as they perform the activity.

5. The Science Stuff

It is much easier for students to add new ideas to a topic in which they already have some knowledge or experience than it is to start from scratch on a topic they know nothing about. This section builds on the experience of the investigation.

6. Making Connections

Lessons learned become more permanent when they are related to other situations and ideas in the world. This section reminds students of concepts and ideas they likely already know. The scientific explanation for what the students observed should be more meaningful if it can be connected to other experiences and/or prior knowledge. The more connections that are made, the greater the students' level of understanding will become.

7. Dig Deeper

This section provides ideas for additional things to do or look up at home. Students will often want to learn more than what was in the lesson. This will give them some choices for further study. Students who show an interest in their own unanswered questions should be allowed to pursue their interests, provided the teacher approves of an alternative project. Students should aim to do at least one project per week from Dig Deeper or other project choices, recording the projects they choose to do, along with the completion date, in a notebook or journal. The minimum requirements from this section should correspond to each student's grade level.

8. What Did You Learn?

This section contains a brief assessment of the content of the lesson in the form of mostly short-answer questions.

9. The Stumpers Corner

The students may write two things they would like to learn more about or two "stumper" questions (with answers) pertaining to the lesson. Stumper questions are short-answer questions to ask to family or classmates, but they should be hard enough to be a challenge.

Note to the Teacher

The books in this series are designed to be applicable mainly for grades 3–8. The recommendations for K–4 were also considered, because basic content builds from one level to another. The built-in flexibility allows younger students to do many of the investigations, provided they have good reading and math skills. Middle school students will be presented the basic concepts for their level, but will benefit from doing more of the optional research and activities.

We feel it is best to leave grading up to the discretion of the teacher. However, for those who are not sure what would be a fair way to assess student work, the following is a suggestion.

1. Completion of 20 activities with write-up of observations — ⅓
2. Completion of What Did You Learn Questions + paper and pencil quizzes — ⅓
3. Projects, Contests, and Dig Deeper — ⅓

The teacher must set the standards for the amount of work to be completed. The basic lessons will provide a solid foundation for each unit, but additional research and activities are a part of the learning strategy. The number of required projects should depend on the age, maturity, and grade level of the students. All students should choose and complete at least one project each week or 20 per semester. 5th and 6th graders should complete 25 projects per semester. A minimum guide for 7th and 8th graders would be 30 projects. The projects can be chosen from "Dig Deeper" ideas or from any of the other projects and features. Additional projects would give extra credits. By all means, allow students to pursue their own interests and design their own research projects, as long as you approve first. Encourage older students to do the more difficult projects.

As students complete each investigation and other work, they should record what they did and the date completed in the student journal. You may or may not wish to assign a grade for total points. But a fair evaluation would be three levels, such as: minimum points, more than required, and super work. Remember, the teacher sets the standards for evaluating the work.

Ideally, if students miss one of the investigations, they should find time to make it up. When this is not practical, make sure they understand the questions at the end of the lesson and have them do one of the "Dig Deeper" projects or another project.

You should be able to complete most of the 20 activities in a semester. Suppose you are on an 18-week time frame with science labs held once a week for two or three hours. Most investigations can be completed in an hour or less. Some of the shorter activities can be done on the same day or you may choose to do a teacher demonstration of a couple of the labs.

It is suggested that at least five hours a week be allotted to the investigations, contests, sharing of student projects, discussion of "What Have You Learned" questions, and research time. More time may be needed for some of the research and projects. Count projects, contests, and Dig Deeper activities equally. There are many possible activities from which students may choose.

Any time chemicals are used that might irritate eyes, safety glasses should be required. This is also a requirement for being around flames and other devices used for heating water or other chemicals. They are as important as safety belts are for children in a moving vehicle. Some activities should be done only as demonstrations led by an adult, but a student helper can assist if the student is wearing safety glasses and covering to protect clothes.

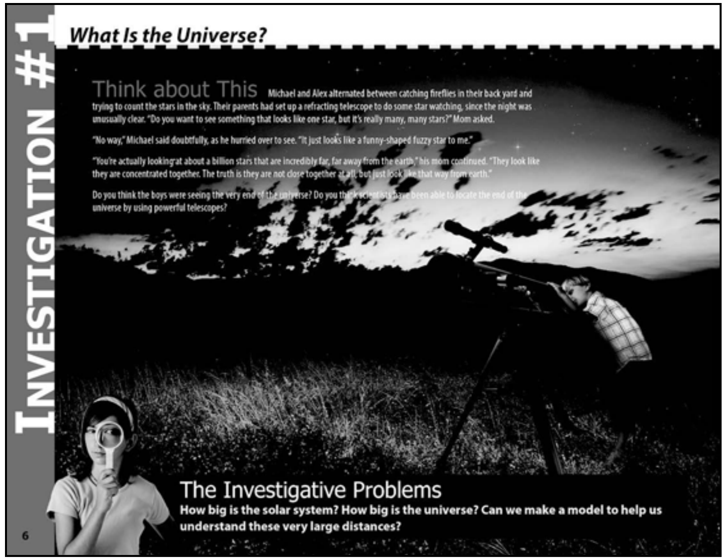
Refer students to textbooks or other references to help them answer questions, but also encourage them to think of their own explanations. It is not too early to help students understand that science is mostly about finding explanations for things they have observed and about finding patterns in nature. When controlled experiments are done, help them identify the controls and the variable.

Most of the supplies and equipment can be obtained locally. Also, supplies, videos of lessons, and other helps are available at www.investigatethepossibilities.org.

Objectives

1. The solar system is made up of the sun, planets, moons of planets, asteroid belt, TNOs, comets, and anything else held in orbit around the sun by its gravitation pull. The solar system is billions of miles across. It is measured in units called Astronomical Units (AU) which is equal to the distance from the earth to the sun.

2. The size of the solar system is too big to view it all at one time. We used a penny model to represent the distances of the planets to the sun, letting one penny equal one AU.



INVESTIGATION #1

What Is the Universe?

Think about This Michael and Alex alternated between catching fireflies in their back yard and trying to count the stars in the sky. Their parents had set up a refracting telescope to do some star watching, since the night was unusually clear. "Do you want to see something that looks like one star, but it's really many, many stars?" Mom asked.

"No way," Michael said doubtfully, as he hurried over to see. "It just looks like a funny-shaped fuzzy star to me."

"You're actually lookingat about a billion stars that are incredibly far, far away from the earth," his mom continued. "They look like they are concentrated together. The truth is they are not close together at all, but just look like that way from earth."

Do you think the boys were seeing the very end of the universe? Do you think scientists have been able to locate the end of the universe by using powerful telescopes?

The Investigative Problems

How big is the solar system? How big is the universe? Can we make a model to help us understand these very large distances?

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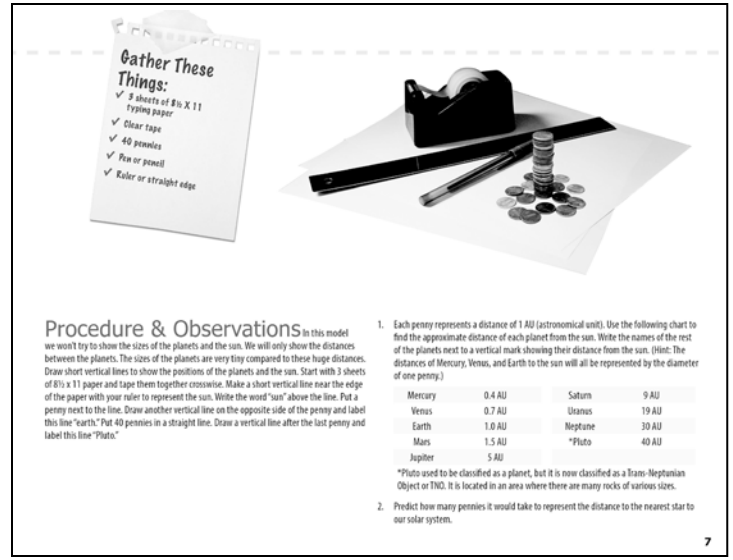

Procedure & Observations In this model we won't try to show the sizes of the planets and the sun. We will only show the distances between the planets. The sizes of the planets are very tiny compared to these huge distances. Draw short vertical lines to show the positions of the planets and the sun. Start with 3 sheets of 8½ x 11 paper and tape them together crosswise. Make a short vertical line near the edge of the paper with your ruler to represent the sun. Write the word "sun" above the line. Put a penny next to the line. Draw another vertical line on the opposite side of the penny and label this line "earth." Put 40 pennies in a straight line. Draw a vertical line after the last penny and label this line "Pluto."

1. Each penny represents a distance of 1 AU (astronomical unit). Use the following chart to find the approximate distance of each planet from the sun. Write the names of the rest of the planets next to a vertical mark showing their distance from the sun. (Hint: The distances of Mercury, Venus, and Earth to the sun will all be represented by the diameter of one penny.)

Mercury	0.4 AU	Saturn	9 AU
Venus	0.7 AU	Uranus	19 AU
Earth	1.0 AU	Neptune	30 AU
Mars	1.5 AU	*Pluto	40 AU
Jupiter	5 AU		

*Pluto used to be classified as a planet, but it is now classified as a Trans-Neptunian Object or TNO. It is located in an area where there are many rocks of various sizes.

2. Predict how many pennies it would take to represent the distance to the nearest star to our solar system.

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3. Our solar system is part of the Milky Way Galaxy. There are at least 200 billion stars in the Milky Way Galaxy. Distances across the galaxy have to be measured in very large units, such as light years, which is the distance light travels in one year.

4. There are billions of galaxies in the universe. The universe seems to be millions of light years across.

5. Astronomers have not been able to identify the end of the universe and do not know how large it is. Evidence indicates the most distant stars may be millions of light years away.

6. Some of the methods used to estimate distances of objects in space are given.

Note

The following is an alternative way to model the size of the solar system. Find a large enough space that is safe for students to walk. If this activity is done, it should be supervised by a teacher or a parent, because it involves walking a long distance. If you only have a limited space, you can zigzag back and forth as long as the students understand they should be walking farther away from the "sun." Use something like a soccer ball to represent the sun. Use modeling clay to form balls to represent the planets. Mercury will only be a few millimeters in diameter. Jupiter will be a couple of centimeters in diameter. Use a reference book or the Internet to make the clay balls larger or smaller as needed. The exact sizes of the planets are not too important as long as they are relatively close. Place the clay models on index cards that are labeled with the names of the planets.

Begin by placing the "sun" (soccer ball) on the ground. Then take 7 steps away from the sun and place the clay ball representing Mercury on the ground on an index card labeled "Mercury." Take 6 more steps to Venus, placing the clay ball for Venus on an index card labeled "Venus." Repeat this process for each planet. Take 5 more steps to Earth; 10 more steps to Mars; 66 more steps to Jupiter; 78 more steps to Saturn; 173 more steps to Uranus; 195 more steps to Neptune; and 168 more steps to Pluto (which is now referred to as a "Trans-Neptunian Object" or TNO rather than a planet).

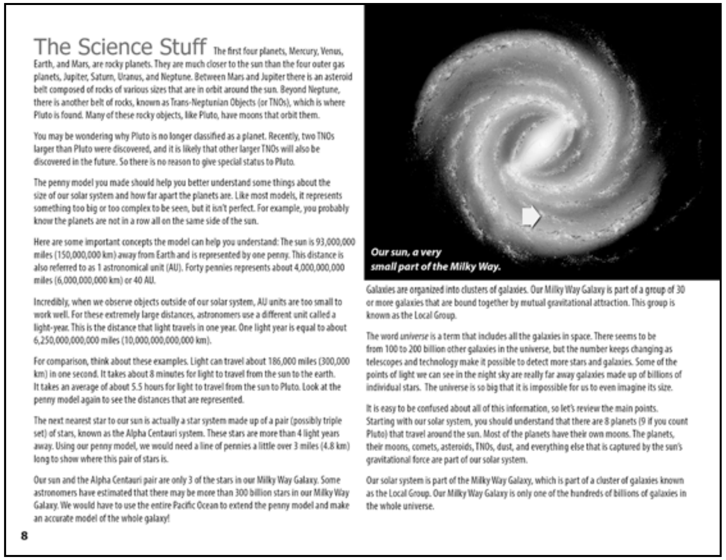
Be sure students realize that this is an imperfect model of the solar system. All of the planets are not on the same side of the sun at the same time. The model is only designed to help them visualize how far the planets are from the sun and to get an idea of the sizes of the planets.

Discussions

What are some of the things the sun, the moon, and the stars reveal to us about God?

The human body is made up of trillions of cells. Do you think a trillion stars in space are more awesome than the trillion cells that work together in your body in perfect harmony?

Read Isaiah 40:26. Do you find it amazing that God knows the name of every star?



The Science Stuff

The first four planets, Mercury, Venus, Earth, and Mars, are rocky planets. They are much closer to the sun than the four outer gas planets, Jupiter, Saturn, Uranus, and Neptune. Between Mars and Jupiter there is an asteroid belt composed of rocks of various sizes that are in orbit around the sun. Beyond Neptune, there is another belt of rocks, known as Trans-Neptunian Objects (or TNOs), which is where Pluto is found. Many of these rocky objects, like Pluto, have moons that orbit them.

You may be wondering why Pluto is no longer classified as a planet. Recently, two TNOs larger than Pluto were discovered, and it is likely that other larger TNOs will also be discovered in the future. So there is no reason to give special status to Pluto.

The penny model you made should help you better understand some things about the size of our solar system and how far apart the planets are. Like most models, it represents something too big or too complex to be seen, but it isn't perfect. For example, you probably know the planets are not in a row all on the same side of the sun.

Here are some important concepts the model can help you understand: The sun is 93,000,000 miles (150,000,000 km) away from Earth and is represented by one penny. This distance is also referred to as 1 astronomical unit (AU). Forty pennies represents about 4,000,000,000 miles (6,000,000,000 km) or 40 AU.

Incredibly, when we observe objects outside of our solar system, AU units are too small to work well. For these extremely large distances, astronomers use a different unit called a light-year. This is the distance that light travels in one year. One light year is equal to about 6,250,000,000,000 miles (10,000,000,000,000 km).

For comparison, think about these examples. Light can travel about 186,000 miles (300,000 km) in one second. It takes about 8 minutes for light to travel from the sun to the earth. It takes an average of about 5.5 hours for light to travel from the sun to Pluto. Look at the penny model again to see the distances that are represented.

The next nearest star to our sun is actually a star system made up of a pair (possibly triple set) of stars, known as the Alpha Centauri system. These stars are more than 4 light years away. Using our penny model, we would need a line of pennies a little over 3 miles (4.8 km) long to show where this pair of stars is.

Our sun and the Alpha Centauri pair are only 3 of the stars in our Milky Way Galaxy. Some astronomers have estimated that there may be more than 300 billion stars in our Milky Way Galaxy. We would have to use the entire Pacific Ocean to extend the penny model and make an accurate model of the whole galaxy!

Our sun, a very small part of the Milky Way.

Galaxies are organized into clusters of galaxies. Our Milky Way Galaxy is part of a group of 30 or more galaxies that are bound together by mutual gravitational attraction. This group is known as the Local Group.

The word *universe* is a term that includes all the galaxies in space. There seems to be from 100 to 200 billion other galaxies in the universe, but the number keeps changing as telescopes and technology make it possible to detect more stars and galaxies. Some of the points of light we can see in the night sky are really far away galaxies made up of billions of individual stars. The universe is so big that it is impossible for us to even imagine its size.

It is easy to be confused about all of this information, so let's review the main points. Starting with our solar system, you should understand that there are 8 planets (9 if you count Pluto) that travel around the sun. Most of the planets have their own moons. The planets, their moons, comets, asteroids, TNOs, dust, and everything else that is captured by the sun's gravitational force are part of our solar system.

Our solar system is part of the Milky Way Galaxy, which is part of a cluster of galaxies known as the Local Group. Our Milky Way Galaxy is only one of the hundreds of billions of galaxies in the whole universe.

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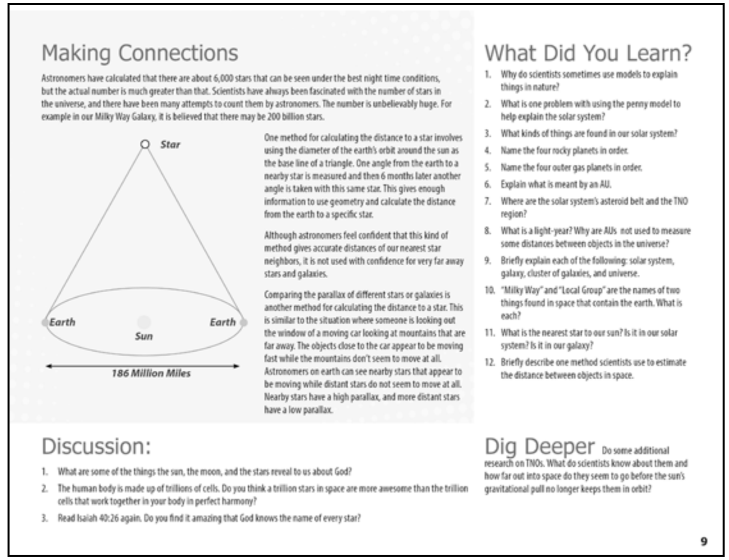

Making Connections

Astronomers have calculated that there are about 6,000 stars that can be seen under the best night time conditions, but the actual number is much greater than that. Scientists have always been fascinated with the number of stars in the universe, and there have been many attempts to count them by astronomers. The number is unbelievably huge. For example in our Milky Way Galaxy, it is believed that there may be 200 billion stars.

One method for calculating the distance to a star involves using the diameter of the earth's orbit around the sun as the base line of a triangle. One angle from the earth to a nearby star is measured and then 6 months later another angle is taken with this same star. This gives enough information to use geometry and calculate the distance from the earth to a specific star.

Although astronomers feel confident that this kind of method gives accurate distances of our nearest star neighbors, it is not used with confidence for very far away stars and galaxies.

Comparing the parallax of different stars or galaxies is another method for calculating the distance to a star. This is similar to the situation where someone is looking out the window of a moving car looking at mountains that are far away. The objects close to the car appear to be moving fast while the mountains don't seem to move at all. Astronomers on earth can see nearby stars that appear to be moving while distant stars do not seem to move at all. Nearby stars have a high parallax, and more distant stars have a low parallax.

Discussion:

1. What are some of the things the sun, the moon, and the stars reveal to us about God?
2. The human body is made up of trillions of cells. Do you think a trillion stars in space are more awesome than the trillion cells that work together in your body in perfect harmony?
3. Read Isaiah 40:26 again. Do you find it amazing that God knows the name of every star?

What Did You Learn?

1. Why do scientists sometimes use models to explain things in nature?
2. What is one problem with using the penny model to help explain the solar system?
3. What kinds of things are found in our solar system?
4. Name the four rocky planets in order.
5. Name the four outer gas planets in order.
6. Explain what is meant by an AU.
7. Where are the solar system's asteroid belt and the TNO region?
8. What is a light-year? Why are AUs not used to measure some distances between objects in the universe?
9. Briefly explain each of the following: solar system, galaxy, cluster of galaxies, and universe.
10. "Milky Way" and "Local Group" are the names of two things found in space that contain the earth. What is each?
11. What is the nearest star to our sun? Is it in our solar system? Is it in our galaxy?
12. Briefly describe one method scientists use to estimate the distance between objects in space.

Dig Deeper

Do some additional research on TNOs. What do scientists know about them and how far out into space do they seem to go before the sun's gravitational pull no longer keeps them in orbit?

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What Did You Learn?

1. Why do scientists sometimes use models to explain things in nature? *Models help students to visualize things that are too large or too complex to see.*
2. What is one problem with using the penny model to help explain the solar system? *The planets are not all lined up on the same side of the sun.*
3. What kind of things are found in our solar system? *The planets, their moons, comets, asteroids, TNOs, dust, and everything else that is captured by the sun's gravitational force.*
4. Name the four rocky planets in order. *Mercury, Venus, Earth, and Mars*
5. Name the four outer gas planets in order. *Jupiter, Saturn, Uranus, and Neptune*
6. Explain what is meant by an AU. *AU stands for Astronomical Unit. This is the distance from the sun to the earth and is equal to 93,000,000 miles or 150,000,000 km.*
7. Where are the solar system's asteroid belt and the TNO region? *The asteroid belt is located between Mars and Jupiter. The TNO region is beyond Neptune.*
8. What is a light-year? Why are AUs not used to measure some distances between objects in the universe? *A light-year is the distance light can travel through space in a year. This distance is equal to about 6 trillion miles or 10 trillion km. AU units are too small to be convenient for measuring very large distances.*
9. Briefly explain each of the following: solar system, galaxy, cluster of galaxies, and universe. *The solar system is made up of the sun and the planets that orbit the sun, along with everything else held in place by the sun's gravity. A galaxy is made up of millions or billions of stars that are bound together by gravitational attraction. A cluster of galaxies is a group of galaxies that are relatively close together. The universe is a term used to include everything that exists in the natural world.*
10. "Milky Way" and "Local Group" are the names of two things found in space that contain the earth. What is each? *The Milky Way is the name given to the galaxy that contains our solar system. Local Group is the name of a cluster of a few dozen galaxies that contains our Milky Way Galaxy.*
11. What is the nearest star to our sun? Is it in our solar system? Is it in our galaxy? *The nearest star to our sun is Alpha Centauri (probably a pair or triplet of stars). It is not in our solar system, but it is in our galaxy.*
12. Briefly describe one method scientists use to estimate the distance between objects in space. *Two methods are described in Making Connections. Students should choose one of these to describe: measuring angles between earth and a star, and the parallax method.*

INVESTIGATION #2

Spreading Out the Heavens

Think about This

Julie and Justin were laughing hysterically as their father showed an old video of them playing on a slide. He showed the clip in forward motion and then showed it in reverse. "Do it again," they said in unison. Their big sister Anita laughed along with them. Then she thought how neat it would be if a video of their lives for the past year could be shown in reverse to show how much everyone had grown and changed over the year.

Her father said, "Let's take this idea a little further. What if there was a video of the entire universe that could be shown in reverse right back to the beginning of everything? What do you think we'd see at the very beginning?"

Anita remembered seeing a TV program once about the big-bang theory. It showed the beginning of the universe as a small dense ball. Then, about 15 billion years ago, the ball exploded and everything began to move out in all directions forming stars, planets, moons, and all the other objects in the universe. Do you think, if it were possible to see a movie of the universe in reverse, it would begin as a small dense "ball" 15 billion years ago?

The Investigative Problems

Is the universe expanding? What are some possible explanations for an expanding universe?

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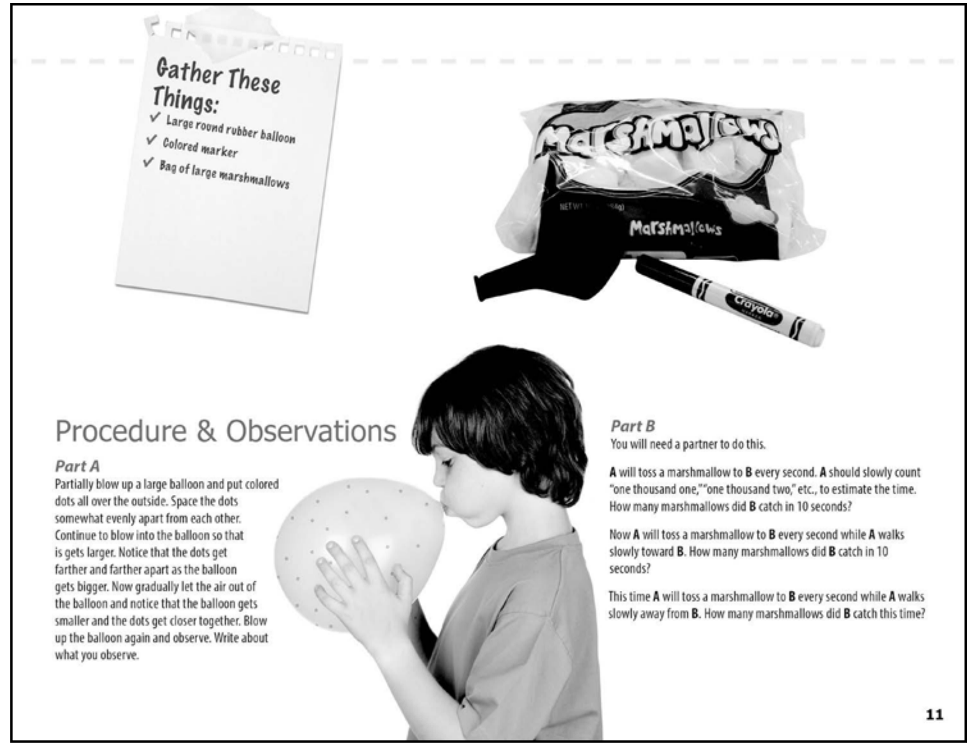


Gather These Things:

- ✓ Large round rubber balloon
- ✓ Colored marker
- ✓ Bag of large marshmallows

Procedure & Observations

Part A

Partially blow up a large balloon and put colored dots all over the outside. Space the dots somewhat evenly apart from each other. Continue to blow into the balloon so that is gets larger. Notice that the dots get farther and farther apart as the balloon gets bigger. Now gradually let the air out of the balloon and notice that the balloon gets smaller and the dots get closer together. Blow up the balloon again and observe. Write about what you observe.

Part B

You will need a partner to do this.

A will toss a marshmallow to **B** every second. **A** should slowly count "one thousand one," "one thousand two," etc., to estimate the time. How many marshmallows did **B** catch in 10 seconds?

Now **A** will toss a marshmallow to **B** every second while **A** walks slowly toward **B**. How many marshmallows did **B** catch in 10 seconds?

This time **A** will toss a marshmallow to **B** every second while **A** walks slowly away from **B**. How many marshmallows did **B** catch this time?

11

Objectives

1. Astronomers began to recognize a sun-centered solar system in the 1500s as they studied the movements of planets. Telescopes had been invented and were used by Copernicus, Galileo, and Kepler during this time.

2. In the early 1900s, Hubble discovered other galaxies and noted that all their spectra showed a red shift. This was a clue that the galaxies were expanding throughout the universe.

3. The big-bang theory was proposed based on the red shifts in the light spectra and a 2.7° K temperature throughout space. The nebula hypothesis was proposed to explain how the stars and the planets formed after the big bang. According to these proposals, billions of years would be required.

4. Creation scientists have proposed alternative explanations that only require thousands of years. They also accept the idea that the stars were spread out as they were created.

Notes

History books tend to portray the disagreements between Galileo and the Catholic pope as an ongoing battle between science and religion. This is greatly exaggerated in many accounts of history. Try to help students see that true science and the Bible are not in conflict. Conflicts arise from how evidence is interpreted. Darwinian evolution and billions of years of slow changes are the two main areas where science and the Bible have different interpretations of origins.

What Did You Learn?

1. What scientist discovered that there were other galaxies in the universe in addition to the galaxy our earth is in? *Edwin Hubble*

2. What evidence did Edwin Hubble discover that caused him to conclude that galaxies are moving and getting farther away from the earth? *He collected spectra of light from 46 galaxies and noted that there was always a red shift in the colors of the visible spectrum that came from these galaxies.*

The Science Stuff

There has been an assortment of ideas through the ages about how to explain the universe, but there are still more questions than answers. Some of the first real clues about how the solar system works came from scientists like Copernicus (1473–1543), Galileo (1564–1642), and Kepler (1571–1630). At the time when Copernicus cautiously proposed that the planets moved around the sun, he did not have the benefit of telescopes. Both Galileo and Kepler were able to study the planets with telescopes. The explanation for movements of planets and stars caused people to eventually shift from believing in an earth-centered universe to accepting a sun-centered solar system. The change to a sun-centered solar system took a long time, but by the time of Isaac Newton (1642–1727), the evidence had persuaded most scientists it was true.

Another major shift in viewing the universe came as Edwin Hubble (1889–1953) made use of more powerful telescopes and other kinds of technology during the early 1900s. At first Hubble agreed with other astronomers of his day that the solar system, the stars, comets, asteroids, and nebulae were all part of the same galaxy. At this time, it was thought that there was nothing outside of our galaxy.

But in 1923, as Hubble began studying a fuzzy patch of sky called the Andromeda Nebula, he found that it contained individual stars. After making many observations and then doing some mathematical calculations, he finally concluded that he was viewing a set of stars that made up another galaxy completely separate from the one the earth was in. In the next few years, Hubble was able to identify several other galaxies. By 1929, most astronomers had come to believe that our Milky Way Galaxy was only one of millions of galaxies in the universe.

Hubble discovered that not all galaxies are alike. He found elliptical galaxies, spiral galaxies, and barred spiral galaxies. We know today that there are even more different kinds of galaxies than Hubble imagined.

Eventually, Hubble collected spectra of light from 46 galaxies. He noted that there was always a red shift in the colors of the visible spectrum that came from these galaxies.

Since red is the longest visible wavelength, a red shift in the spectrum would indicate that the light from these galaxies was being stretched out as it reached the earth. This information led scientists to believe that all of the galaxies were moving away from the earth and getting farther apart over time. If the spectrum colors had always shifted toward blue/violet, the shortest wavelengths, this would have been a clue that the galaxies were moving toward the earth and getting closer together. If the light the galaxies emit was stretched out by the time it reached the earth, the light spectrum would show a red shift. This is a clue that the universe is expanding.

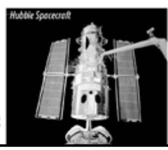
The activity with the marshmallows should help you understand this concept. The light (or sound) waves are squeezed together as one object approaches another. The light (or sound) waves are spread out as one object moves away from another one. The marshmallows were easier to catch as the pitcher moved away from the catcher, representing how the waves were stretched out a little.

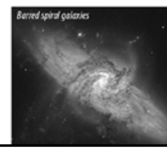
Not long after the red shift discovery, the "big-bang" theory was introduced. Many astronomers reasoned that if galaxies in the universe are now expanding, there must have been a time in the past when they were closer together. They kept trying to rewind time and concluded that the galaxies must have started out from the same place. They reasoned that their expanding motion must have started from an explosion. Hence, the name the "big bang."

Soon, another theory known as the nebula theory was made based on the big-bang theory. According to this theory, after the big bang occurred, large clouds of dust particles were thrown into space and began to spin. Within these spinning clouds, other whirlpools formed. Then the particles in these whirlpools condensed to form galaxies, stars, planets, and other objects in space.

There are problems with the big-bang theory, the nebula hypothesis, and billions of years to create everything. However, all three principles continue to be accepted by mainstream scientists.

An alternative explanation that is consistent with Scripture is being studied by some astronomers. They are looking at the possibility that the originally created universe was much smaller than it is today. And, at some point after creation, it expanded to the present size, causing light rays to also be "stretched" in the process. Some creation scientists believe this process might be something like how you observed the spots on the balloon expand, as the balloon got bigger.





Making Connections

Recall that *parallax* is a method for estimating extremely distant objects in space and that such objects may appear not to be moving. When objects are trillions of miles away, they appear to be staying still even though they are probably moving.

The idea that the universe was stretched out is found in several places in the Bible. Isaiah wrote that God stretched out the heavens like a curtain. Notice that this idea is like the big bang in suggesting that there was once an expanding of the sky.

The appearance of a red shift in the light reaching the earth from distant galaxies is based on an assumption that light from these galaxies is moving away from the earth. This should work in the same way that radar uses the Doppler effect to give readings about the speed and direction of moving clouds. Waves from the clouds are compressed as they move toward the radar and are stretched out as they move away from the radar.

Dig Deeper

What are the differences between astronomers and astrologers? Try to find the names of early civilizations that studied the heavenly bodies. (Keep in mind that some of the early survivors of the Flood were expert astronomers.)

Find out how a Doppler radar works and how weather forecasters use them in predicting weather. Compare Doppler weather radar with instruments that astronomers use to measure shifts in light spectra.

Position yourself on a sidewalk. Have a parent drive a car down the road next to the sidewalk while continuously blowing the car horn. Describe how the pitch of the car horn changes as the car approaches and then moves away. The change in pitch is known as the Doppler effect.

Draw shapes of different kinds of galaxies.

What Did You Learn?

1. What scientist discovered that there were other galaxies in the universe in addition to the galaxy our earth is in?
2. What evidence did Edwin Hubble discover that caused him to conclude that galaxies are moving and getting farther away from the earth?
3. Before the time of Hubble, did scientists believe all the stars in the universe were in the same galaxy?
4. Which color in the visible spectrum has the longest wavelength?
5. Is the bluish/violet end of the visible spectrum made up of shorter waves or longer waves?
6. What major shift in thinking about the solar system came from scientists like Copernicus, Galileo, and Kepler?
7. The "big-bang" theory is based on what main piece of evidence? Does this prove that the big bang actually happened?
8. Briefly tell about the "nebula theory." Does it attempt to explain the origin of all the stars, planets, moons, comets, rocks, and dust in the universe?
9. What instrument was available for Galileo, Kepler, and Hubble to use that Copernicus did not have?
10. Give the shape of two different kinds of galaxies.
11. All galaxies appear to be moving. Why are we unable to look at them and tell that they are moving?

Pause and Think

There are numerous references in Job, Isaiah, Jeremiah, and Zechariah that refer to a mighty act of God in which He spread out the stars in the sky.

Isaiah 48:13 Isaiah 51:13 Isaiah 40:22 Job 26:7
Isaiah 42:5 Isaiah 44:24 Isaiah 45:12 Job 37:18
Jeremiah 10:12 Zechariah 12:1

3. Before the time of Hubble, did scientists believe all the stars in the universe were in the same galaxy? *Yes*

4. Which color in the visible spectrum has the longest wavelength? *Red*

5. Is the bluish/violet end of the visible spectrum made up of shorter waves or longer waves? *Shorter*

6. What major shift in thinking about the solar system came from scientists like Copernicus, Galileo, and Kepler? *They concluded that the sun was the center of the solar system, and that the earth and the planets revolved around the sun.*

7. The "big-bang" theory is based on what main piece of evidence? Does this prove that the big bang actually happened? *A red shift in the light spectra of galaxies is the main piece of evidence for the big-bang theory. This does not prove the big bang actually happened. There are other logical explanations for this evidence.*

8. Briefly tell about the "nebula theory." Does it attempt to explain the origin of all the stars, planets, moons, comets, rocks, and dust in the universe*? The nebula theory proposes that, following the big bang, there were swirling clouds throughout space. Eventually these clouds formed swirling eddies of gas that condensed into stars and planets and all the other objects in space.*

9. What instrument was available for Galileo, Kepler, and Hubble to use that Copernicus did not have? *Telescopes*

10. Give the shape of two different kinds of galaxies. *Shapes include spiral galaxies, elliptical galaxies, barred spiral galaxies, ring galaxies, and other shapes.*

11. All galaxies appear to be moving. Why are we unable to look at them and tell that they are moving? *The parallax effect makes it difficult to detect movement in objects that are extremely far away.*