Grades 5-8

FOCUS ON

MIDDLE SCHOOL ASTRONOMY

Teacher's Manual

Rebecca W. Keller, PhD

REAL SCIENCE 4 Kids

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A Note From the Author

This curriculum is designed to give students both solid science information and hands-on experimentation. The middle school material is geared toward fifth through eighth grades, and much of the information in the text is very different from what is taught at this grade level in other textbooks. This is a *real* science textbook, so scientific terms are used throughout. It is not important at this time for students to master the terminology, but it *is* important that they be exposed to the real terms used to describe science.

For students, each chapter has two parts: a reading part in the *Focus On Middle School Astronomy Student Textbook* and an experimental part in the *Focus On Middle School Astronomy Laboratory Workbook*. In this teacher's manual, an estimate is given for the time needed to complete each chapter. It is not important that both the reading portion and the experimental portion be concluded in a single sitting. It may be better to have students do these on two separate days, depending on the interest level of the child and the energy level of the teacher. Also, questions not addressed in the *Teacher's Manual* may arise, and extra time may be required to investigate these questions before proceeding with the experimental section.

Each experiment is a *real* science experiment and not just a demonstration. They are designed to engage students in actual scientific investigation. The experiments are simple but are written the way real scientists actually perform experiments in the laboratory. With this foundation, it is my hope that students will eventually begin to think of their own experiments and test their own ideas scientifically.

Enjoy!

Rebecca W. Keller, PhD

How To Use This Manual

Each chapter in this *Focus On Middle School Astronomy Teacher's Manual* begins by providing additional information for the corresponding chapter in the *Focus On Middle School Astronomy Student Textbook*. This supplementary material is helpful when questions arise while students are reading the textbook. It is not necessary for students to learn this additional material since most of it is beyond the scope of this level. However, the teacher may find the information helpful when answering questions.

The second part of each chapter in the *Teacher's Manual* provides directions for the experiments in the *Laboratory Workbook* as well as answers to the questions asked in each experiment and review section. All of the experiments have been tested, but it is not unusual for an experiment to produce an unexpected outcome. Usually repeating an experiment helps both student and teacher see what might have occurred during the experimental process. Encourage the student to troubleshoot and investigate all possible outcomes. However, even repeating an experiment may not produce the expected outcome. **Do not worry if an experiment produces a different result.** Scientists don't always get the expected results when doing an experiment. The important thing is for students to learn about the scientific method and to make observations, think about what is taking place, and ask questions.

Getting Started

The experimentation process will be easiest if all the materials needed for the experiment are gathered together and made ready before beginning. It can be helpful to have a small shelf or cupboard or even a plastic bin dedicated to holding most of the necessary chemicals and equipment. The following Materials at a Glance chart lists all of the materials needed for each experiment. An additional chart lists the materials by type and quantity. A materials list is also provided at the beginning of each lesson.

Laboratory Safety

Most of these experiments use household items. Extra care should be taken while working with all materials in this series of experiments. The following are some general laboratory precautions that should be applied to the home laboratory:

- Never put things in your mouth without explicit instructions to do so. This means that food items should not be eaten unless tasting or eating is part of the experiment.
- Wear safety glasses while using glass objects or strong chemicals such as bleach.
- Wash hands before and after handling all chemicals.
- Use adult supervision while working with electricity and glassware, and while performing any step requiring a stove.

Materials at a Glance

Experiment 1	Experiment 2	Experiment 3	Experiment 4	Experiment 5
pencil flashlight	2 sticks (used for marking) 2 rulers string protractor pencil square grid or graph paper	basketball ping-pong ball flashlight empty toilet paper tube tape scissors a dark room	modeling clay: gray white brown red butter knife or sculptor's knife ruler	modeling clay: gray white brown red blue green orange butter knife or sculptor's knife ruler

Experiment 6	Experiment 7	Experiment 8	Experiment 9	Experiment 10
the 8 planet models from Experiment 5 ruler (in centimeters) pencil large 1x1 meter (3x3 ft.) flat surface for drawing (can use cardboard or construction paper) large open space at least 10' long push pin piece of string a meter long	pen paper your imagination	pen paper computer and internet service Google Earth	pen paper computer and internet service Google Earth	pen paper computer and internet service Google Earth

Materials at a Glance

By type

Equipment	Materials	Locations
computer and internet service and Google Earth flashlight knife, butter or sculptor's protractor ruler in centimeters rulers (2) scissors	*Focus On Middle School Astronomy Laboratory Workbook* basketball (1) modeling clay: gray white brown red blue green orange paper, blank (several sheets) paper, square grid or graph (several sheets) pen pencil ping-pong ball (1) planet models (8) from Experiment 5 push pin (1) sticks—used for marking (2) string (several meters) surface, flat—for drawing, 1x1 meter (3x3 ft.), can use cardboard or construction paper tape toilet paper tube, empty (1)	room, dark space, large open, at least 10' long

Contents

Chapter 1: What Is Astronomy?

Time Required

Text reading	30 minutes
Experimental	1 hour

Materials

pencil
flashlight

Overall Objectives

This chapter will introduce students to the scientific discipline of astronomy. It begins with a brief history of astronomy and discusses how views of the cosmos have changed over time. Students should understand that the scientific discipline of astronomy began thousands of years ago and that modern astronomy utilizes the disciplines of chemistry a*nd physics to* study the universe.

1.1 Introduction

Astronomy comes from the Greek words *aster* which means "star" and *nomas* which means "to assign, distribute, or arrange."

Literally, astronomy means to assign, distribute, or arrange the stars.

Explore open inquiry with the following questions:

- *How would you arrange the stars?*
- *When you observe the stars, what do you see? Are they all the same size, shape, color?*
- *How easy is it to see the stars with your eyes?*
- *Can you observe any patterns in the stars?*

1.2 Early Astronomers

It is difficult to pin down the exact date when people began to observe the stars. Some ancient cave dwellings have primitive records showing human observations of the night sky from as early as 3500-3000 BC (BCE).

Many early civilizations used the positions of the Sun, Moon, and stars as a way to measure time and the changing seasons.

Stars can be observed anywhere in the world; however, constellations vary depending on the observer's location. Because the Earth is spherical, constellations seen from the northern hemisphere differ from constellations seen from the southern hemisphere.

Explore open inquiry with the following questions:

- *How might the constellations be different if the Earth were flat?*
- *If you were an early astronomer, how might you use the stars to measure time or the passing of seasons?*
- *Today, how often do people use the stars or the Moon to measure time?*
- *What other ways do modern people use to measure time?*
- *Which do you think is more accurate, modern timekeeping or ancient timekeeping? Why?*

1.3 Modern Astronomers

Advances in technology allow modern astronomers to look more closely at the celestial bodies seen by ancient astronomers and also to discover many more objects in space. Some of the tools that astronomers are now using will be discussed in more detail in Chapter 2.

It is important for the students to understand that astronomers rely on other scientific disciplines such as physics, chemistry, and mathematics to help them understand objects in space—how they move, how stars generate energy, what celestial bodies are made of, etc. Current scientific knowledge is based on a foundation of centuries of scientific thought and experimentation.

Explore open inquiry with the following questions:

- *How do you think math and physics help astronomers understand planets, stars, and solar systems?*
- *How does chemistry help astronomers understand how stars work?*
- *Do you think we could have landed on the Moon without math or physics?*
- *Do you think we might be able to fly to another solar system as we discover more math and physics? Why or why not?*

1.4 Changing Views of the Cosmos

One of the most important shifts in understanding happened when our view of the solar system shifted from geocentric (Earth-centered) to heliocentric (Sun-centered).

Changing such a viewpoint is a major contribution of scientific investigation. It is important for students to understand how this shift took place and the struggle that occurred between individuals with opposing viewpoints.

Explore open inquiry with the following questions:

- *If you were an early astronomer and did not have the tools of modern astronomy, what might be your observation about how the Earth, Sun, and Moon move with respect to each other?*
- *Do you think it would be easy to believe that the Earth is the center of the universe? Why or why not?*
- *Astronomers like Galileo had to convince others that observing the Sun or Moon moving in the sky was not proof that the Earth was the center. How hard do you think it is for people to change their ideas and trust new data?*

1.5 Summary

Discuss with the students the main points of this chapter.

- Astronomy is the field of science that studies celestial bodies. Remind students that a celestial body is any object in space, such as a planet or star.
- Review the activities of early astronomers and how they used the stars and movements of the planets to create calendars and to keep time.
- Discuss with the students how modern astronomy incorporates the disciplines of chemistry and physics to study the universe. Note that chemistry and physics are essential for understanding astronomy.
- Lead a discussion about how the entire way of viewing the world underwent a major shift when the idea of the geocentric cosmos was replaced by that of a heliocentric cosmos.

Experiment 1: Constellations

Date: _____

Objective

_____

_____

Hypothesis

_____

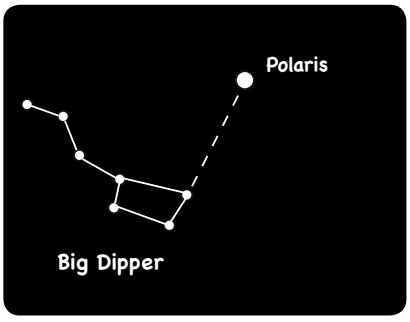
_____

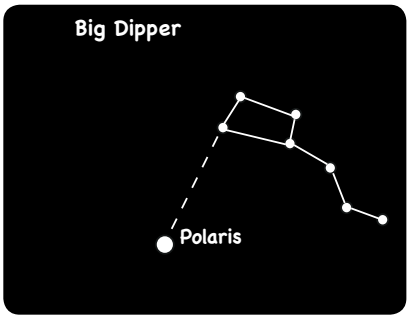
Materials

pencil
flashlight

Results

❶ In the evening on a clear night go outside and, without using a compass, locate "north." To do this you will need to find the Big Dipper. The Big Dipper is a set of stars that form the shape of a "dipping spoon." (The Big Dipper is not an official constellation but is called an asterism—a small group of stars.) The two stars on the end of the dipping spoon point to the star Polaris.





The goal of this experiment is to help students become familiar with the night sky, the stars, and several constellations.

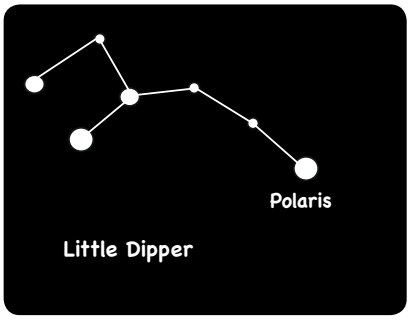
This is an observational exercise, so there is no "Experiment" section

NOTE: This experiment is only applicable to locations in the northern hemisphere.

Polaris is the "North Star," and when you turn towards Polaris, you are pointing "north." It doesn't matter in which direction the Big Dipper is pointing, the two end stars always point to the North Star. The North Star is the only star in the sky that doesn't move (much). All of the constellations appear to move around the North Star. Once you find the North Star you can find nearby constellations.

❷ Now that you have found the North Star, try to find the constellation called the "Little Dipper."

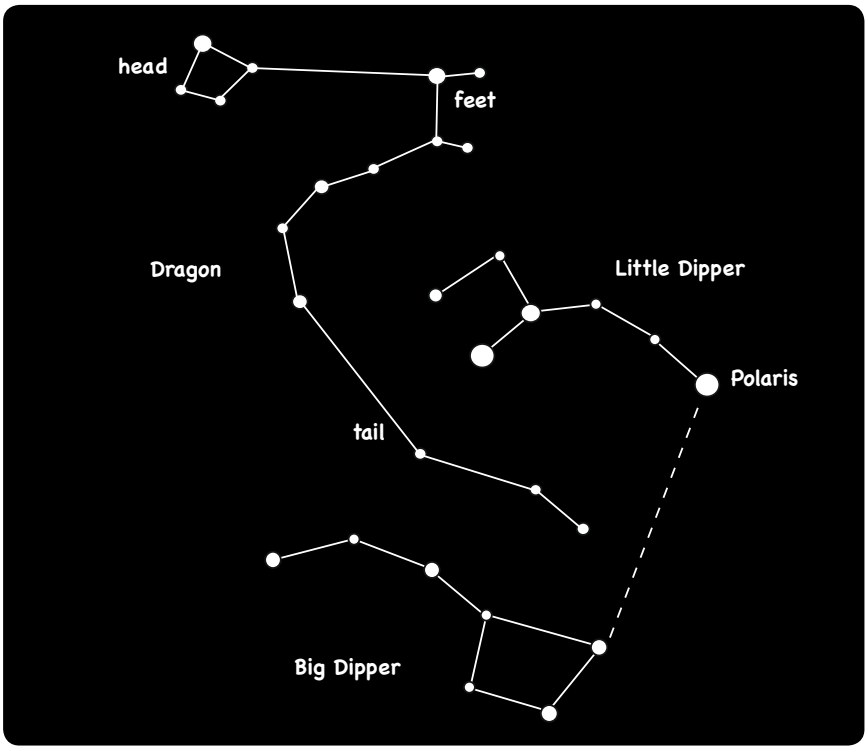
Polaris forms the end of the handle of the Little Dipper.



Draw the Little Dipper constellation as you observe it.

(Drawings may vary.)

❸ Try to locate the "Dragon." The Dragon constellation is between the Big Dipper and Little Dipper.



❹ On the following page, draw the Dragon constellation as you see it.

❺ Count the stars in the Dragon constellation in the image above. Compare this number with the number of stars you've recorded for the Dragon.

Draw the Dragon constellation as you observe it.

(Drawings may vary.)

6 Record your physical location, city, state, or country, whether you are in the Northern or Southern Hemisphere, and the month.

Location _____

_____

Hemisphere _____

Month _____

Conclusions

Summarize how easy or difficult it was to find the North Star, the Big Dipper asterism, and the two constellations—the Little Dipper and the Dragon. What role, if any, does your physical location and the month you made these observations have on your results?

(Answers will vary.)

Review

Answer the following:
(Answers may vary.)

- The word astronomy comes from the Greek word ___*aster*___ which means ___*star*___ and the Greek word ___*nomas*___ which means ___*to assign, distribute, or arrange*___.
- The word astronomy means ___*to assign or arrange the stars*___.
- The word geocentric comes from the Greek word ___*geo*___ which means ___*earth*___ and the Greek word ___*kentron*___ which means ___*point or center*___.
- The word geocentric means ___*the Earth is the central point*___.
- The word heliocentric comes from the Greek word ___*helios*___ which means ___*sun*___ and the Greek word ___*kentron*___which means ___*point or center*___.
- The word heliocentric means ___*the Sun is the central point*___.
- A constellation is ___*a group of stars that fit together to form a pattern*___.
- The North Star is also called ___*Polaris*___.