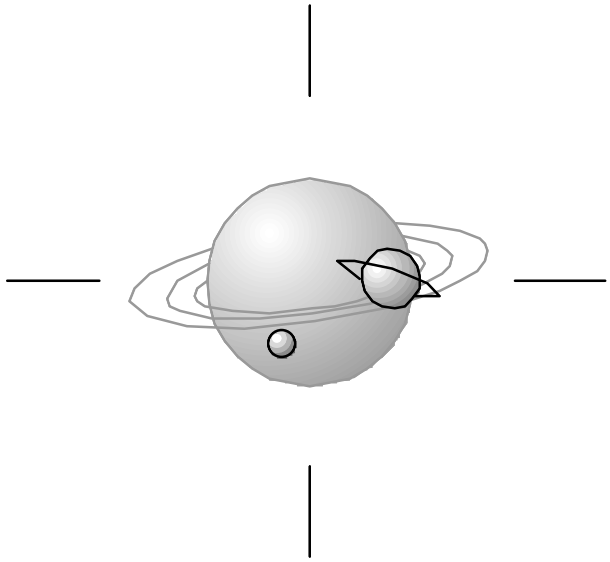


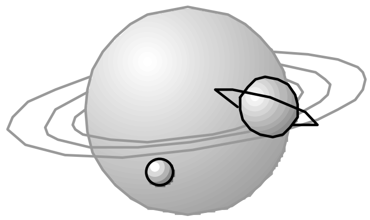
TOPIC C

SKY SCIENCE

GRADE

6

EDMONTON PUBLIC SCHOOLS



TOPIC C

SKY SCIENCE

GRADE

6

- Other Units Available from Edmonton Public Schools -

The elementary science program has been designed as a series of five topics for each grade. Each topic may be developed as a separate unit of study or linked to other topics and other subject areas.

The order of topics within a grade may be varied as part of the instructional plan. Some topics lend themselves to development throughout the school year; for example, Seasonal Changes. Others may be developed as discrete units. Each grade includes one topic emphasising problem solving through technology; and, except for Grade 1, there is a corresponding topic emphasising science inquiry

Grade	Topic
1	A. Creating Colour B. Seasonal Changes C. Building Things D. Senses E. Needs of Animals and Plants
2	A. Exploring Liquids B. Buoyancy and Boats C. Magnetism D. Hot and Cold Temperature E. Small Crawling and Flying Animals
3	A. Rocks and Minerals B. Building with a Variety of Materials C. Testing Materials and Designs D. Hearing and Sound E. Animal Life Cycles
4	A. Waste and Our World B. Wheels and Levers C. Building Devices and Vehicles that Move D. Light and Shadows E. Plant Growth and Changes
5	A. Electricity and Magnetism B. Mechanisms Using Electricity C. Classroom Chemistry D. Weather Watch E. Wetland Ecosystems
6	A. Air and Aerodynamics B. Flight C. Sky Science D. Evidence and Investigation E. Trees and Forests

- Foreword -

The elementary science program engages students in a process of inquiry and problem solving in which they develop knowledge, skills and attitudes. The program is designed to encourage and stimulate children's learning by nurturing their sense of wonderment, by developing skill and confidence in investigating their surroundings, and by building a foundation of experience and understanding upon which later learning can be based. The following principles provide the foundation for the science program:

- Children's curiosity provides a natural starting point for learning.
- Children's learning builds on what they currently know and can do.
- Communication is essential for science learning.
- Students learn best when they are challenged and actively involved.
- Confidence and self-reliance are important outcomes of learning

Each topic within the elementary science curriculum provides opportunities for developing questions, problems, and issues that become starting points for inquiry and problem solving. By engaging in the search for answers, solutions, and in formulating decisions, students have a purpose for learning and an opportunity to develop concepts and skills within a meaningful context. In science inquiry, the focus is on asking questions and finding answers based on evidence. The outcome of inquiry is knowledge. In problem solving through technology, the focus is on practical tasks - finding ways of making and doing things to meet a given need, using materials. The outcome of problem solving is a product or process that one can use.

Each student should be encouraged to handle materials, record and discuss observations, make inferences and analyse results so that they can discover a number of the fundamental principles of science and the nature of scientific investigation. This unit addresses the general and specific learner expectations of the topic, the materials required, the procedure to be followed, and student masters when applicable. Students are encouraged to record findings in a logbook, journal, notebook, or on the student master.

The production of this unit, along with all the others from grades 1 to 6 has evolved over the past two years in an effort to provide elementary teachers with a resource which would meet the requirements of the elementary science program. Teachers are encouraged to select and modify the activities to best meet the needs of their students.

- Acknowledgements -

This unit is one of thirty developed for the new science curriculum. We would like to recognize the following people for their involvement and contributions to this project.

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The activities and information included in these units reflect the expertise of the people involved and the requirements of the science program. We thank the following individuals for their willingness to contribute to the development of this unit:

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- Grade 6 : Skills -

These skills apply to the five topics of study identified for grade 6. The organization of these skills reflects a general pattern of science activity, not a fixed instructional sequence. At grade 6, students normally will show independence and the ability of work cooperatively in exploratory and investigative activities. Limited guidance may be required in defining problems and selecting appropriate variables. At this level, students should be able to describe the purpose of each step followed in investigative activities.

SCIENCE INQUIRY

General Learner Expectations

Students will:

6-1 Design and carry our an investigation in which variables are identified and controlled, and that provides a fair test of the question being investigated.

6-2 Recognize the importance of accuracy in observation and measurement; and apply suitable methods to record, compile, interpret and evaluate observations and measurements.

Specific Learner Expectations

Students will:

Focus

- ask questions that lead to exploration and investigation
- identify one or more possible answers to questions by stating a prediction or a hypotheses

Explore and Investigate

- identify one or more ways of finding answers to given questions
- plan and carry out procedures that comprise a fair test
- identify variables:
    - *identify the variable to be manipulated*
    - *identify variables to be held constant*
    - *identify the variable that will be observed (responding variable)*
- select appropriate materials and identify how they will be used

- modify the procedures as needed
- work individually or cooperatively in planning and carrying out procedures
- identify sources of information and ideas and demonstrate skill in accessing them. Sources may include library, classrooms, community and computer-based resources.

<u>Reflect and Interpret</u>

- communicate effectively with group members in sharing and evaluating ideas, and assessing progress
- record observations and measurements accurately, using a chart format where appropriate. Computer resources may be used for record keeping and for display and interpretation of data.
- evaluate procedures used and identify possible improvements
- state an inference, based on results. The inference will identify a cause and effect relationship that is supported by observations.
- identify possible applications of what was learned
- identify new questions that arise from what was learned

- Grade 6 : Attitudes -

These attitudes apply across the five topics of study identified for grade 6.

General Learner Expectations

Students will:

6-4 Demonstrate positive attitudes for the study of science and for the application of science in responsible ways.

Specific Learner Expectations

Students will show growth in acquiring and applying the following traits:

- curiosity
- confidence in personal ability to learn and develop problem-solving skills
- inventiveness and open-mindedness
- perseverance in the search for understandings and for solutions to problems
- flexibility in considering new ideas
- critical-mindedness in examining evidence and determining what the evidence means
- a willingness to use evidence as the basis for their conclusions and actions
- a willingness to work with others in shared activities and in sharing of experiences
- appreciation of the benefits gained from shared effort and cooperation
- a sense of personal and shared responsibility for actions taken
- respect for living things and environments, and commitment for their care.

- Grade 6 : Understandings -

SKY SCIENCE

Overview

Students learn about objects in the day and night sky. Through direct observations and research, students learn about the motions and characteristics of stars, moons and planets. Using simple materials, such as balls and beads, students create models and diagrams which they use to explore the relative position and motion of objects in space. As a result of these studies, students move from a simple view of land and sky, to one that recognizes Earth as a sphere in motion within a larger universe. With new understanding, students revisit the topics of seasonal cycles, phases of the Moon and the apparent motion of stars.

General Learner Expectations

Students will:

6-7 Observe, describe and interpret the movement of objects in the sky; and identify pattern and order in these movements.

Specific Learner Expectations

Students will:

1. Recognize that the Sun and stars *emit* the light by which they are seen and that most other bodies in space, including Earth's Moon, planets and their moons, *comets*, and *asteroids*, are seen by , are seen by *reflected* light.

2. Describe the location and movement of individual stars and groups of stars *(constellations)* as they move through the night sky.

3. Recognize that the apparent movement of objects in the night sky is regular and predictable, and explain how this apparent movement is related to Earth's *rotation.*

4. Understand that the Sun should never be viewed directly, nor by use of simple telescopes or filters, and that safe viewing requires appropriate methods and safety precautions.

5. Construct and use a device for plotting the apparent movement of the Sun over the course of a day; e,g., construct and use a sundial or shadow stick.

6. Describe seasonal changes in the length of the day and night and in the angle of the Sun above the horizon.

7. Recognize that the Moon's *phases* are regular and predictable, and describe the cycle of its phases.

8. Illustrate the phases of the Moon in drawings and by using improvised models. An improvised model might involve such things as a table lamp and a sponge ball.

9. Recognize that the other eight known planets, which revolve around the Sun, have characteristics and surface conditions that are different from Earth; and identify examples of those differences.

10. Recognize that not only Earth, but other planets, have moons; and identify examples of similarities and differences in the characteristics of those moons.

11. Identify technologies and procedures by which knowledge, about planets and other objects in the night sky, has been gathered.

12. Understand that Earth, the Sun and the Moon are part of a solar system that occupies only a tiny part of the known universe.

- Background Information for Teachers -

Sky Science gives students the basic tools and knowledge to explore the solar system and the universe. Students should come away from this study with a sense of awe and wonder. The size of the universe, the distances between stars, the composition and size of stars and galaxies and the speed of light are all topics that can stimulate, and in some cases, overwhelm the imagination. Our student's exposure to "Star Trek" and other shows of the same genre have already created a sense of wonder (the world of entertainment is fraught with unrealistic theories and stories of space travelers). In spite of these misconceptions this unit is able to build on that fascination with the stars. There are numerous opportunities for integrating math, language arts and social studies learner expectations as you progress through this unit.

The Sun is the star that is at the centre of our solar system. *Stars* are the heat sources of the universe and come in all sizes, colours, compositions and temperatures. Stars emit light through nuclear fusion which happens deep inside the star. Our Sun is burning hydrogen at a rate of more then 1 million tonnes per second and turning that hydrogen into helium. By fusing the atoms together, the Sun produces heat and light which radiate outward. The surface temperature of the Sun is about 5000 degrees Celsius. The Sun is considered an average and very stable star and should have enough fuel to last another 4-5 billion years. There are other stars in our galaxy which are just like our Sun but also ones which are much smaller (the size of the Earth) and much larger (the size of the orbit of Jupiter). Each of these stars have their own life cycle some lasting only a few million years and others lasting billions of years. Star brightness is described in terms of magnitude. The brightest stars may be as much as 1 000 000 times brighter than our Sun; white dwarfs are about 1 000 times less bright.

Our Sun is one of about 200 billion stars in our galaxy- the *Milky Way*. Since we can not see what our galaxy looks like, astronomers use its size, mass, and gravitational attraction to conclude that it is most likely similar to our closest neighbour the Andromeda galaxy. The Milky Way is one of billions of galaxies within the viewing range of the larger modern telescopes.

The star nearest to our solar system is the triple star Proxima Centauri, which is about 40 trillion km from Earth or a little more than 4 light-years. (A *light-year* is the distance light travels in a year at the rate of 300 000 km/sec about 10 trillion kilometres). To give your students an idea of how fast this is you can relate it to the distance around the Earth at the Equator which is about 40 000 km. Light would travel around the Equator 7 and a half times in one second. Driving to Banff from Edmonton takes approximately 4 hours and the distance traveled is about 400 km. Light would travel that same distance much faster than the blink of an eye.

Our own solar system is large enough to use a unit based on the distance from the Sun to the Earth (A.U. astronomical unit about 149 million kilometres).

To put the idea of distance into perspective, think of traveling in car at 100 km/hr. To get to the moon would take about 167 days, to get to Mars it would take 26 years and to make it to Pluto more then 5 500 years.

The Earth is one of nine planets in our solar system that orbit the Sun. The inner 4 planets all have a solid surface. The next four, beyond the asteroid belt, are gas giants because not only are they much larger then the inner planets but also do not have solid surfaces. The outer most planet is again a rocky planet but one that may have been captured by our solar system after it was formed.

Each of the planets has its own unique characteristics: *Mercury* has no atmosphere and because of its proximity to the Sun has a surface that has continuously been bombarded by meteors and comets. *Venus* has a very dense atmosphere of carbon dioxide and the surface shows very little geological activity. *Earth* is the only planet that we know of that has liquid water and a temperature that can sustain life. *Mars* has a thin atmosphere of carbon dioxide, two very distinct polar ice caps, the largest canyon and the highest volcano, discovered to date, in the solar system. Between Mars and Jupiter lies the asteroid belt a region that contains thousands of pieces of rock which some astronomers believe could have made a planet but due to the gravitational tugging from Jupiter was unable to form. The largest planet and first gas giant is Jupiter. Jupiter has a very turbulent atmosphere with one storm (the great red spot) having been visible since Galileo first saw it some 400 hundred years ago. *Saturn* is sometimes called the most beautiful of all the planets because of its spectacular ring system. The rings are less then 2 kilometres thick and stretch outwards more then 25,000 kilometres from the surface of the planet. *Uranus* and *Neptune* are similar in size and make up. Both have a methane atmosphere with Uranus showing an almost green colour and Neptune a deep blue. Uranus is unique in that its axis of rotation is tilted almost 85 degrees (almost to the horizontal) so it could be said that Uranus is rolling through the solar system. The farthest planet from the Sun is *Pluto*, a small rocky planet with a very elliptical orbit. Its orbit actually takes it inside the orbit of Neptune until the year 2000.

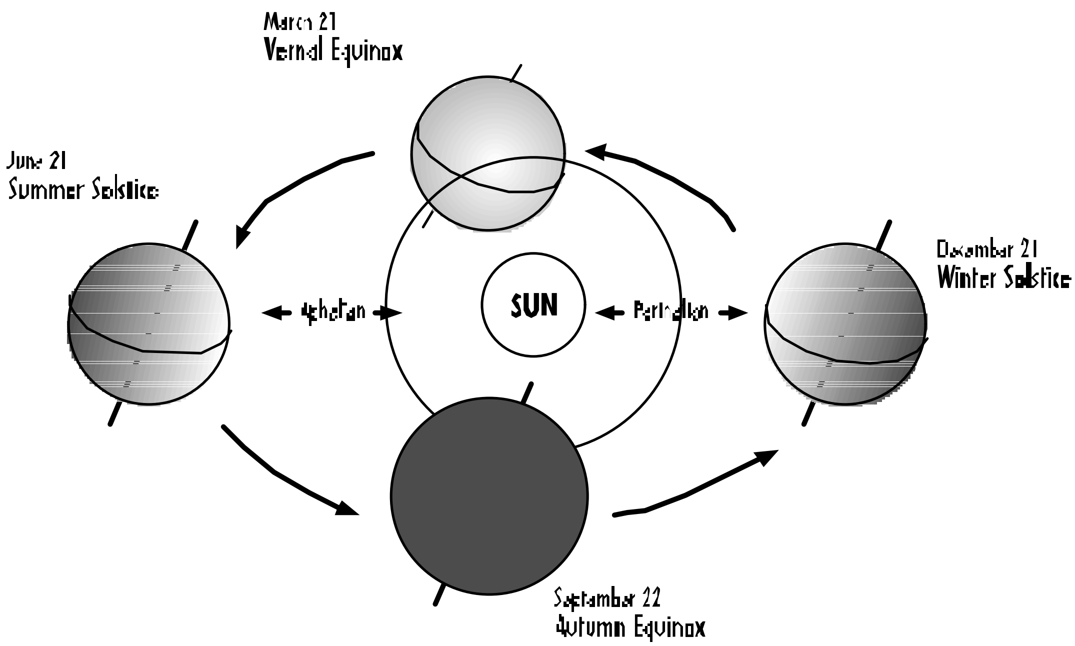
By observing the heavens it looks like things are constant and not moving. In fact close observations show that not only do the planets move, but the stars also move. The reason we can not see this movement is because of the great distances involved. If we would travel ahead in time by 20 million years the constellations as we know them would look much different from what we see today.

Stars form patterns in the sky. It is these patterns that the ancient Greeks used to tell stories of mythology and their Gods. There are 88 constellations that make up the sky. The best way to describe a constellation is a connect-the-dot drawing of picture in the sky. Sometimes patterns are formed which do not form a constellation but are still used by astronomers to find their way around the heavens. Patterns like the summer triangle, *big dipper* and the great square of pegasus are called *asterisms* and form patterns which are not constellations.

Your students may recall that the Earth is tilted 23.5 degrees off of vertical. This not only gives us the seasons but also changes which constellations we see. Those constellations that we can see year round (Ursa Major, Ursa Minor, etc.) are said to be *circumpolar*.

Your students may think that they are sitting still as they sit in their desks or stand in one spot in the room. In fact, the Earth is turning on its axis at approximately 1700 km/h. The Earth orbits the Sun at over 100 000 km/h. Our solar system orbits the centre of the galaxy at over 200 km/sec and the galaxy is hurtling through space at approximately 19 km/sec. All of this should lend new meaning to the term “standing still.”

One of the results of the tilt of the Earth’s axis on its yearly journey around the Sun is the seasons. Our seasons are largely dictated by the angle at which the Sun’s rays strike the surface of the Earth.

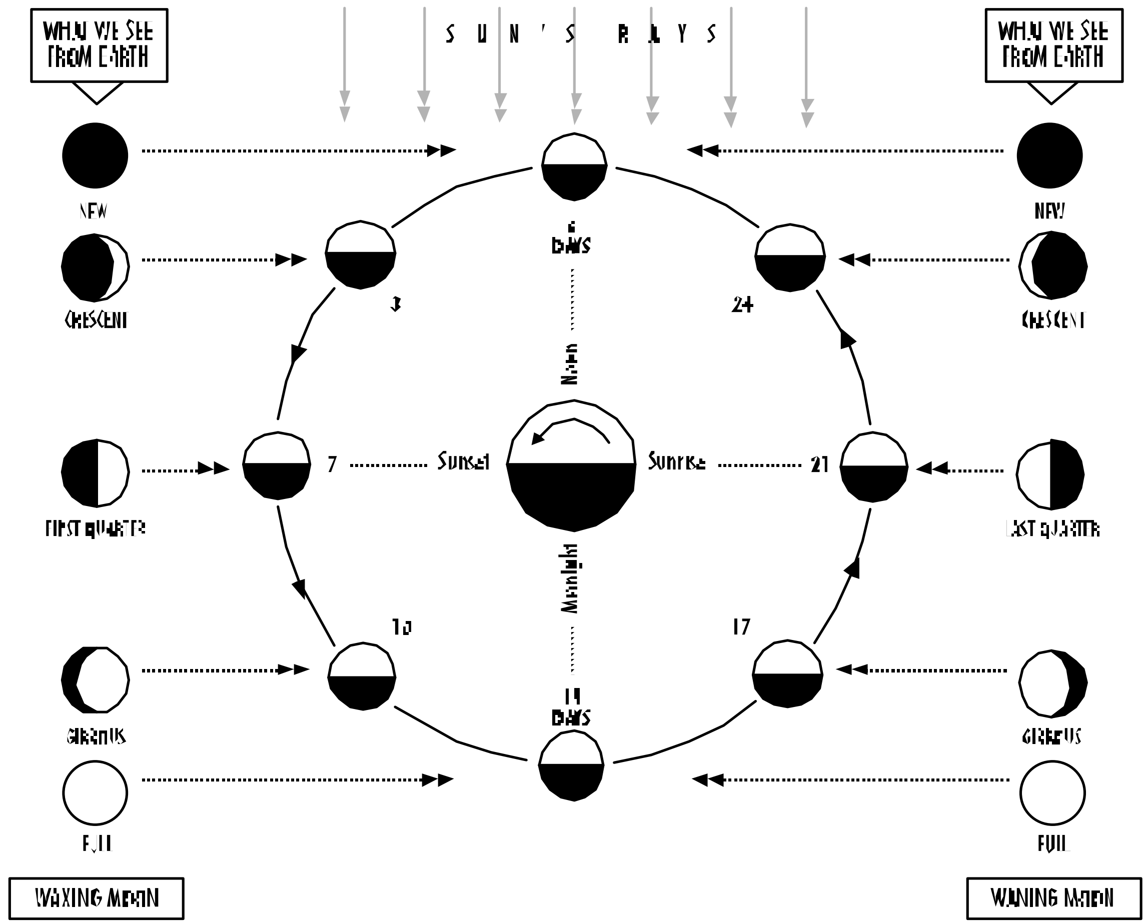


Our atmosphere acts like a giant fish bowl. In the day, the light from the Sun is scattered so that we mostly see the blue end of the spectrum. If you observe the sky just before sunrise or sunset you might be able to see other colours of the spectrum with blue, and orange being the most visible. The scattering of the light also blocks out the light from other stars so that we are unable to see stars during the daytime.

The *Moon*, our closest neighbor in space is a satellite of the Earth. The proper term for 'moons', those bodies that orbit other planets, is *satellites*. The Moon is about one-fourth the size of the Earth. The moon moves in an elliptical orbit, about 400 000 km above the Earth. It travels at an average speed of 3 700 km/h. The moon rotates on its axis once in about the same period of time it takes to complete one revolution around the Earth, accounting for the fact that the same portion of the moon is always facing the Earth.

The moon shows progressively different phases as it revolves around the Earth. Half the Moon is always in sunlight, just as half the earth has day while the other half has night. The phases of the moon depend on how much of the sunlit half can be seen at any one time. With the Moon making its monthly trek around the Earth it looks like it is changing shape. This change in shape is known as the *"Phases of the Moon."* Half of the Moon is always in Sunlight and it is the vantage point from Earth that causes the observer to notice a change in the phase. The Moon travels in a counter clockwise motion around the Earth. When the Moon is between the Earth and the Sun, we see the unlit side of the Moon. This is called the *new Moon* and we do not see the Moon. Over the next 7 days the Moon moves from West to East rising higher in the sky each night. When a small crescent is visible (about 2 days after the new Moon) we have reached the crescent phase. Each day the Moon gets fuller until we see the Moon at a right angle to where the Sun has set. At this point we see 1/4 of the Moon illuminated and we say it is the *first quarter*. Over the next 7 days the Moon will become fuller yet. When it is almost full it is said to be in the *gibbous phase*. About 14 days after the new Moon the Moon is opposite of the setting Sun (the Earth is now between the Sun and the Moon) and we see 1/2 of the Moon (this is known as the *full moon* since we see the full face of the Moon). In the 2 weeks that the Moon goes from new to full we say it is *waxing.* After the full moon when the Moon starts getting smaller it is said to be *waning.* The 7 days following full moon show the Moon loosing some of its shape until we again see only a quarter of the Moon, which is the last quarter. Between the full and last quarter the Moon goes through another gibbous phase . In the next 7 days the Moon moves from the last quarter to the new Moon, again going through the crescent phase.

Some students will question why we do not have an eclipse of the Sun every new moon and a lunar eclipse on full moons. The reason is that the orbit of the Moon is inclined 5 degrees to the plane of the Earth and the Sun so most months the Moon is either above or below this plane. When the Moon intersects the plane during a full moon we have a lunar eclipse. This is to say that the Earth is between the Sun and the Moon and direct sunlight does not reach the Moon. The Moon will take on a cooper red colour as the light from the sun is bent through the Earth's atmosphere and light from the red end of the spectrum strikes the Moon and is reflected back.



When the Moon is between the Earth and the Sun, the disc of the Moon perfectly matches that of the Sun. The result is one of the most beautiful sights in the world – a *total solar eclipse*. During a solar eclipse the light from the Sun is blocked out and we see only the Corona or the atmosphere of the Sun. Scientists take this opportunity to study the Corona since it is hidden all other times. By studying the Corona scientists are better able to understand how stars work and how their gravity affects the temperature and radiation that the star produces.

Your students may also want to know if the eight other planets in our solar system have moons. Some of them have satellites and some do not. Jupiter has 16 moons, Saturn more than 20 and Mercury and Venus have no satellites. It should be pointed out to your students that the proper term for *moons* is *satellites.* The Moon is the proper name give to the satellite of the Earth.

The invention of the telescope by Galileo opened up the heavens to investigation. Since that time people have gazed upward with wonder and been intrigued by what is out there. Since the time of Galileo telescopes have been getting bigger and more able to gather light from celestial bodies. The more light they can gather the more information we gather. The space race of the 1960's and 1970's led to great discoveries and a new thirst for knowledge. First there was the quest to go to the Moon, then the Pioneer and Voyager spacecraft were sent to explore the planets. The information that they sent back has led to new discoveries and new questions that need to be answered. By sending probes to other worlds we are trying to better understand how the Earth functions in our solar system and where the universe came from. 1996 brought discoveries of other planets in our galaxy, this will no doubt change the way we look at the universe.

The *Hubble* Space Telescope has given us a very clear look at nebulae, distant galaxies and nearby stars. With each new discovery we learn a little bit more as we attempt to unravel the mysteries of space.

The future will see bigger and better telescopes that can look farther and more clearly into space. We will send probes to the outer planets and maybe, in the not to distance future, we will again travel to another world just as we did in the 1970's when we traveled to the Moon.

Our understanding of space and the Universe has evolved as technology has enabled us to "see" beyond our planet. The probes sent to other planets and other star systems and refinement of telescopes with the ultimate telescope being the Hubble Space Telescope that allows us to see the sky away from all atmospheric interference, have greatly shaped our current view of the Universe.

Through direct observation, research, recording data, demonstrations, hands on activities, videos, stories, etc., students will move from a simple view of the land and sky to one that recognizes Earth as a sphere in motion within a larger universe.

Because a night sky is needed to observe many of the workings of the universe, some student observations will need to be done at home, then recorded and brought back to school for discussion, graphing, analysis, etc.

Although it is recommended that this unit be taught during the winter months, as the winter sky is best for constellation and Moon observations any time of the year is fine.

Because of the complexity of some concepts and the chance of uncooperative weather, it is essential to provide students with a variety of resources; especially ways of seeing the universe in motion. Videos such as *"Bill Nye the Science Guy- Earth Science :The Moon, Outer Space, Earth Seasons"*, and a visit to the *Space and Science Centre Planetarium*, are highly recommended. See the *Bibliography*.

The sky beyond our planet remains a source of mystery and wonder. The *Sky Science* unit while meeting the requirements of the Alberta curriculum only touches on many topics that will fascinate and be of great interest to your students. We encourage you, as time allows, to boldly go…

INTRODUCTORY ACTIVITIES

Demonstration: Constructing a Comet

Students will observe physical changes in a model of a comet.

Materials:

water *(3 cups)*
sand or dirt *(2 small spoonfuls)*
dark corn syrup
mixing bowl *(metal)*
work gloves
large mixing spoon
dry ice *(2-3 cups)*
ammonia
ice chest
plastic garbage bags
hammer
paper towels

Procedure:

1. Cut open one garbage bag and line a bowl with it.

2. Place water in mixing bowl and add sand and stir well.

3. Add ammonia and corn syrup and stir well.

4. Place dry ice in 3 garbage bags that have been placed inside of each other (wear gloves).

5. Crush dry ice by pounding with hammer.

6. Add dry ice to the rest of the ingredients in mixing bowl, and stir vigorously.

7. Continue stirring until mixture is almost totally frozen.

8. Take *comet* out of the bowl with plastic liner and shape into a ball.

9. Unwrap the *comet* as soon as it holds it shape.

10. Place *comet* on display for students to observe throughout the day as it begins to melt. and *sublimate* (turn directly from a solid to gas – which is what carbon dioxide does at room temperature and comets do under the conditions of interplanetary space when they are heated by the Sun).

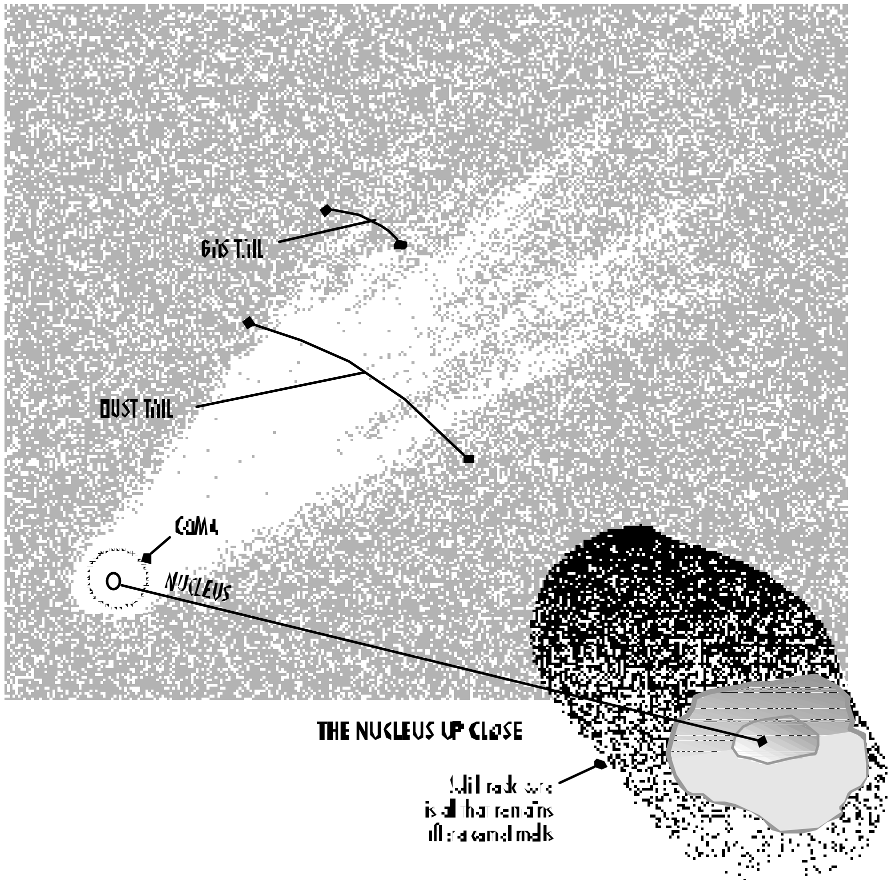
Teacher’s Notes and Debriefing:

In the demonstration of the changes in the comet, it’s important to note that the water represents ice in the comet, dirt represents space debris, syrup represents organic material, dry ice represents frozen CO_2. All of these materials, as well as ammonia, were discovered in the tail of a comet by a probe. Dry ice is frozen carbon dioxide gas which will sublime back into a gas if the temperature is not below the freezing point of carbon dioxide (-78.5°C). For this reason dry ice cannot be stored for more than a few hours, even in a freezer. Purchase dry ice the day of the demonstration and keep it in a small cooler during this time.

This demonstration should be done early in the day as it take several hours to view the changes. The students will observe the *comet* beginning to sublimate (turn directly from solid to gas without becoming a liquid). This simulates what happens to a comet when it travels close to the Sun. As the day goes on the comet will become crater-filled. A real comet becomes crater-filled also and may eventually break into several pieces or disintegrate entirely.

CAUTION: Students should not handle the *comet* with bare hands!

A *comet or “hairy star”* is a celestial body that is usually in an elliptical orbit around the Sun. A comet resembles a dirty snowball. It is made mostly of ice and dirt, but may also contain organic matter (compounds containing carbon). As the comet approaches the Sun it becomes very bright and may develop a brilliant tail sometimes extending many millions of kilometers into space. This tail is caused by the solar heat which evaporates, or sublimates reflects more and more light off of its surface the ices of the comets head called ‘the coma.” The tail of a comet is caused when it approaches the Sun and the surface starts to heat up. This causes material like the water to melt and the carbon dioxide to sublimate. The gases are then pushed away from the comet’s nucleus and coma by the solar wind. The tail of a comet is always pointed away from the Sun. As the comet starts to leave the inner solar system (moves away from the Sun) it again freezes all the material into nucleus until its next return.



Asteroids are chunks of rock that vary in size from very large to quite small. There are also thousands of asteroids that travel through the solar system and are acrossing the orbit of the planets. It is thought that one of these asteroids collided with the Earth about 65 million years ago and brought on the extinction of the dinosaurs. They orbit the Sun between the orbits of Mars and Jupiter. About 3000 asteroids have been discovered. Asteroids may go off course and could then crash into a nearby planet. The asteroid would be attracted by the planet's force of gravity. An asteroid slowly approaching a planet may be pulled into the planet's orbit, may become a moon, or may crash into the planet. Many objects/meteors which enter the Earth's atmosphere burn up completely before hitting the Earth (heated by friction). Some larger meteors have hit the Earth.

Comet Halley orbits the Sun every 76 years. The tail of the comet always points <u>away</u> from the Sun (propelled by solar wind).

To make a crater, drop a marble into a plate of sand. Look at the impression created by the marble and how the sand heaps up the sides of the crater. This is what happens when a meteorite hits Earth.

Activity: Sharing the "Origins" of the Earth and Sky

Students explore the origins of the Earth and sky according to various cultures.

Materials:

story books *(about the origins of the Earth and the sky)*

Procedure:

1. Read the stories and discuss (see *Teacher's Notes and Debriefing).*

Teacher's Notes and Debriefing:

The discussion should focus on the idea that through-out the ages people have been fascinated with the skies and tried to understand and explain celestial bodies and events. Various cultures have used story—myths and folktales to do this.

Teachers may also want to consider both the biblical account and scientific explanations of the origins of the universe.

Activity: Questions For Inquiring Minds

Students have an opportunity to ask questions about the Solar System and the Universe.

Materials:

think pads *(note pads or stapled paper)*
2-5- manila tag strips per student
felt tip markers

Procedure:

1. Pairs of students brainstorm and list questions they have about the *Solar System* and the *Universe.*

2. Students evaluate their list - choosing 2 to 5 good questions to be written on manila tag strips.

3. Manila tag questions are displayed on the walls of the classroom.

4. As the unit progresses, answers to these questions can be shared with the class as they are discovered.. Students may take a question down, only if they replace it with another question.

5. At the very end of the unit (SLE 12), the students can reflect on the remaining questions and add more.

Teacher's Notes and Debriefing:

At the end of the unit there should be many unanswered questions. Students should begin to appreciate that it's impossible to learn all there is to know about the Universe during a short study in grade six.

To get better questions, challenge the students to think of questions they think that no one else would come up with. One of the points of this activity is to demonstrate that our knowledge of the universe is constantly evolving and is dependent upon our questions and our tools (technology).

Activity: Sky Detective Folder

Students create a folder in which to store various devices and materials.

Materials:

duo tang *(or stapled folder, or large envelope)*
Master #1

Procedure:

1. Instruct the students that throughout this unit they are to be observing the night sky and keeping a record of their observations.

2. The folder will be a place to store star charts, sorters, clocks, and other tools that the students will be constructing and using to study the night sky.

3. Have students decorate their folders appropriately.

4. The students are to begin regular observations of the moon and record their observations on Master #1. The frequency of observations should be at least once every three days.

Teacher's Notes and Debriefing:

The students should be encouraged to make their observations at the same time. The moon and its phases will be dealt with in detail during SLE 7 & 8, and it's the observations and resulting diagrams that are important for this activity. The three day interval is suggested in order to observe the phases more easily because the differences will be more pronounced. Around the time of a full moon, the students may want to observe and record nightly. This kit remains under construction throughout the unit since items will be added as students construct them.

When students observe and collect data about the night sky at home, it is imperative that class time be provided to discuss and share this information.

SLE 1: Recognize stars (Sun) emit light by which they are seen and most other bodies are seen by reflected light.

Activity: Starlight, Moonlight?

Students distinguish between celestial bodies that emit light and those that are seen by reflected light.

Materials:

old magazines or other sources of pictures.

Procedure:

1. Have students bring pictures of *light emitting objects* for a class collage. Objects such as stars, electric lights, candles, fireflies etc.

2. Have students bring pictures of objects that we see by reflected light for a class collage. This category is much larger and students will have a much easier time finding pictures. Try to include pictures of planets and satellites of planets.

3. Discuss the differences in the two collages and focus on the celestial bodies.

Teacher's Notes and Debriefing:

The discussion should result in the students understanding that most of the objects we see in the night sky are stars which are light emitting objects and therefore are sources of energy. There are a relatively small number of objects in the night sky that are seen by reflected light the most visible of which is the Moon. The planets and their satellites are seen because they reflect light from our Sun. It is interesting to note that for the most part, stars "twinkle" and planets don't. The reason that the stars twinkle is because they are pinpoints of light in the night sky and their light is affected by convection currents in our atmosphere. The planets may appear to be "star-like" in appearance but careful observation should reveal that they don't twinkle. They are much closer to the Earth and the light that is reflected from their surfaces is much less affected by convection currents in our atmosphere.

SLE 2: Describe the location and movement of individual stars and groups of stars (constellations) as they move through the night sky.

Activity: Starry Starry Night

Students learn how to locate specific stars and groups of stars and to determine their brightness.

Materials:

Masters #2a, #2c and #2e *(student copies)*
Master #2b, #2d, and #2f *(overheads)*
clear cellophane
Master #3 *(photocopied on manila tag)*

Procedure:

1. Students will identify stars according to *clusters.*

   - *Discuss how the Greeks tried to make sense of all the stars. One way was to cluster them into constellations. Have students name some that they know*.

   - *Show Master #2a on overhead and demonstrate the connections between stars. Point out the position of the North Star.*

   - *Students draw in the connections for Ursa Major (**Big Dipper**) and Ursa Minor (**Little Dipper**) on copies of Master #2a..*

   - *Trace the constellations and Master #2c and Orion's belts on Master #2e See Master #2b, #2c and #2f for teacher answers*

2. Students will identify stars by *brightness.*

   - *Students will make a brightness gage.*

     To make:
     - Cut out circles
     - Tape squares of clear cellophane (saran wrap), large enough to cover viewing hole, onto the gage.
     - Each successive hole should have one more layer of cellophane until the 5th hole has 5 layers of cellophane.
     - Label the hole with 5 layers – 4 layers and so on.

     To use:

     View a star through the hole with one layer of cellophane, then through the hole with 2 layers, until you can no longer see the star through the hole. This hole will indicate the magnitude of the star. The *lower* the number, the *brighter* the star.

- Students will add the gauges to their sky detective folder and begin observing and recording at home.

Number of layers of cellophane	Magnitude of the Star
5	1
4	2
3	3
2	4
1	5

3. Students will identify stars by *location* in the sky.

   - *Students will learn and practice a sky measure.*

   - *Students will use their fists to measure degrees and locate stars in the night sky. (A fist width is approximately 10°. By measuring the number of fist widths above the horizon and/or from a particularly bright and easily recognizable star, the students will be able to keep track of a particular star or star group.*

Teacher's Notes and Debriefing:

Stars will be most visible on a clear dark moonless night away from light. Students must go out often to become good star gazers. The easiest star to find is the North Star, Polaris. It is a moderately bright star that can be found on an imaginary line drawn from the pointers of the Big Dipper. (Refer to Master #2b). From the North Star, other stars can be located by using the fist "sky measure" method.

Magnitude of stars are also dependent on the amount of light pollution at the observing site. Students may not get an accurate reading of dimmer stars in the city. They are almost impossible to see.

Please make a distinction of the fact that there will be stars which will be brighter than magnitude 1 and that these will have negative numbers. It is not good science to put absolutes on things especially when most of the planets visible will shine at very bright magnitudes.

Constellations were first recorded and named by the early Greeks who used the patterns in the sky to tell about mythology and the gods.

Begin with the Big Dipper. Start by identifying the seven brightest stars in the Big Dipper. They look like a cooking pot. This does not look much like a bear, so we have to add more stars. First trace the stars out to the nose of the bear, then his belly and finally his feet. Have the students label their bear. Explain that they have to have good imaginations to see a bear.

Once Ursa Major (the Big Bear) is completed use the pointer stars and identify the north star *Polaris*. From here trace out the patterns of the Little Dipper. No other stars are needed for the Little Bear.

Cassiopeia is the "W" that can be seen in the night time sky. Just use the second star in the handle of the big dipper and draw a line through Polaris. Follow this line through the night time sky until you come to the "W" in the sky. this is the constellation of Cassiopeia the queen. Trace out the "W" scientists add the 6th star to make the Queen's throne. From there they draw a queen sitting on the throne. Cassiopeia can be seen in the northern sky at any time of night in the year.

Ursa Major, Cassiopeia and Ursa Minor, are circumpolar constellations meaning they circle the north star and can be seen year round.

Cygnus (the swan) can be seen in the night sky by drawing a line through the two stars on the pot on the dipper (refer to Master #2d). Drawing a line through the two stars and extend it up until you come to the star Deneb. Once Deneb has been located find the remainder of the stars that make up the constellation. Have the students complete Master #2c.

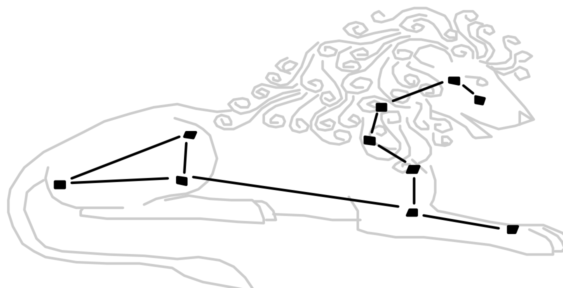
For homework, students can go outside and try and locate some common constellations such as The Big Dipper, Orion the Hunter, and Cassiopeia.

- Look for the north star to find The Big Dipper.
- The two stars on the end of the bowl of The Big Dipper are called *The Two Pointers* because they point straight at the North Star.
- Arcturus is one of the brightest stars in the sky because it is a red giant. Use the handle of The Big Dipper to "*arc to Arcuruus.*"
- Cassiopeia is on the opposite side of the North Star as The Big Dipper and is shaped like a "Big W".
- The constellation Orion is in the south. Look for the three bright stars in a row that make up Orion's belt. Complete Master #2f. (This constellation is visible only in late winter and early spring.)
- Betelgiuse is the brightest star in Orion found in Orion's shoulder.

Although there are some constellations which are circumpolar, the majority are not. Please be very careful when asking students to look for certain constellations and then not hav ing them visible because of the time of year or the time of night they are expected to observe. (i.e. Orion is only visible in the early winter to late spring).

Students who watch a great deal of videos, may recognize Orion from the beginning credits of movies made by Orion Pictures.

Shooting stars (a star falling towards the Earth) is called a *meteor*.



Activity: Shining Students Role Play

Question:

Do constellations change positions in the sky throughout the year?

Materials:

Master #4 *(overhead)*
scissors
light source
yellow construction paper
paper clips

Procedure:

1. Display Master #4 and ask students if they have observed the Big Dipper in any of these positions. Ask students to include this in their nightly observation and recordings.

2. Each student should make a cut out of a single star and attach it to his or her chest using a paper clip. Assign one student to be the Earth (no star).

3. The students wearing the stars should form a circle around perimeter of the room and should face inwards, and the single student who is the Earth should stand near the centre of the room. See the diagram on the next page.

4. Set up the light source in the centre of the room to represent the Sun. The light source should be as bright as possible.

5. The student representing the Earth should orbit slowly, in a counterclockwise direction around the Sun. As the student orbits, he/she should call out the names of student "stars" as they are seen.

6. The students should be encouraged to:

   - *determine when certain "stars" are visible from the Earth*
   - *relate the apparent star movement to the Earth's rotation*

Teacher's Notes and Debriefing:

This activity is to help the students understand the apparent movement of the stars is due to the Earth's rotation.

Specific stars are visible depending upon:

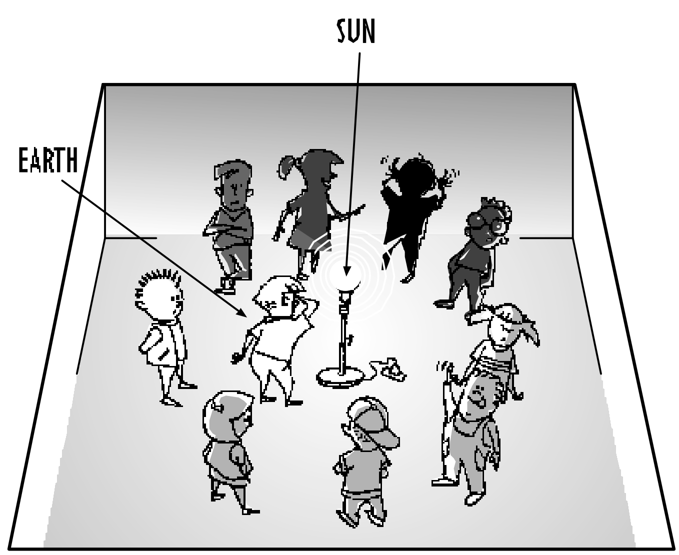
- from where on the planet Earth you view the sky.
- the position of the Earth in its yearly journey around the Sun.
- stars on the opposite side of the Sun are not visible from the Earth.

As the Earth rotates from west to east, the stars appear to rise in the East, move across the south to set in the west.

As seen from the Earth, the sun appears projected against the fixed background stars. As the Earth revolves around the Sun during the year, the sun will appear to move through the stars, making one complete circuit of the sky in 365 days. The stars through which the sun moves are located along the *Ecliptic* and comprise the *12* constellations of the *Zodiac*. The sun spends about one month in each sign of the zodiac.

The stars opposite the sun make up our night sky. Because of the Earth's revolution around the sun, the night sky constantly changes as well. With each season having its distinctive grouping of constellations. The stars that are in the *daytime* sky or winter, for example, will be the *nighttime* stars of summer.

Make sure that when you are representing the Dippers, you put a reference as to the time of day for observation down. The way it is represented in Master #4 now is for the following times: September 15 - Midnight; December 15 - Midnight; March 15 - Midnight; June 15 - Midnight. It may be advantageous to pick days and time when the students will actually be able to go out and observe the movement of the Dipper.



Activity: Star Finders

Students construct and use a 'star-finder' to observe the changing position of the stars in the night sky.

Materials:

Masters #5, #6, #7 and #8
stapler
scissors
file folder
glue
sample of completed *Star Finder*

Procedure:

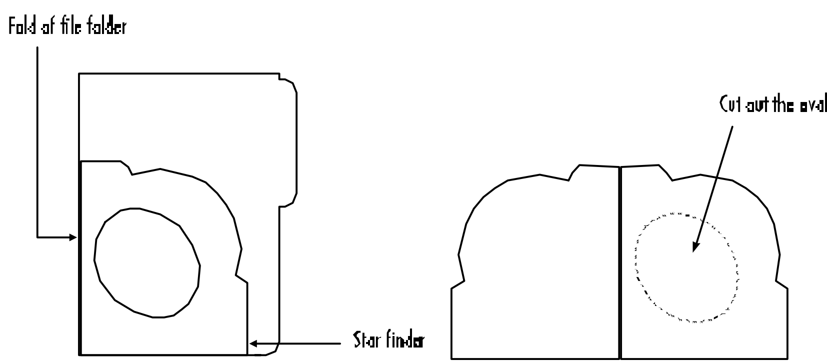
1. Students assemble the *Star Finder.*

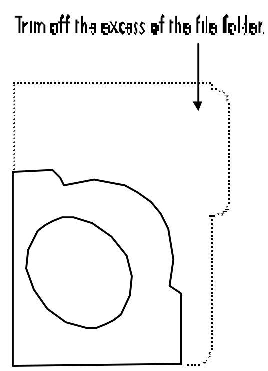
   A. Cut around the dotted line of the star finder on Master #5.

   B. Glue the Star finder on the file folder by lining up the straight edges of the star finder with the edges of the file folder.

   C. Trim off the excess of the file folder.

   D. Open the folder up and cut out the oval following the dotted line.





E. Fold the star finder to form a pocket and staple it together where indicated.

F. Mount Master #6 on a file folder and cut it out on the dotted line. Insert the circle into the star finder pocket.

G. Repeat step F for Master #7.

2. Teach students how to use the *Star Finder* (begin with the simplified *star wheel*--Master #6).

- *Turn the inner dial until the correct date lines up with the desired time (e.g. 8:00 p.m. of that day).*

- *Students should hold the chart in front of them with the "North" corner down if they are facing North and the "South" corner down if they are facing South.*

- *Students should locate the position of the Big Dipper on their charts and predict that constellation's position in the night sky at that time.*

- *Give the students several other times and dates until they understand the process. The more complicated side of the wheel (Master #7) can be introduced as the students become more proficient*.

3. The students should now include this procedure in their nightly observations. Master #8 has been provided to help students record their observations.

Teacher's Notes and Debriefing.

The stars are always changing their position because of the Earth's movement around the Sun and its rotation on its axis. Accordingly, the Star Finder has a rotating wheel and this can be set to show the sky for any date and time. It would be best for the teacher to make one as a sample first before the students begin this activity. Certain parts of constellations will be more readily seen, such as the Big Dipper, Little Dipper. Orion's Belt (3 stars in a row), Cassiopeia (W shaped), Cygnus (X shaped), Pleiades (cluster of 5). Master #7 incorporates several of the skills required for star gazing.

If possible, arrange a class star party for students and their families. Van Gough's painting, *Starry Night* is an exact depiction of the stars seen the night he painted it. Astronomers are able to identify the date that Vincent painted this famous picture.

SLE 4: **Understand that viewing the sun requires special equipment.**

SLE 3: **Recognize that the apparent movement of objects in the sky is regular and predictable and related to the Earth's rotation.**

***NOTE**: It is suggested that SLE 4 be introduced before SLE 3 for safety reasons.*

Demonstration: The Sun's Awesome Power

This activity emphasizes the danger of looking into the sun without eye protection.

Materials:

a sunny window
piece of black construction paper
thermometer
magnifying glass
#14 welder's glass *(optional)*

Procedure:

1. Demonstrate the power of the sun's rays.

    - *Lay a piece of blank paper on a flat table in direct sunlight.*
    - *Students should place their hands on the black paper and note the relative temperature. A thermometer could be used instead to get an actual reading.*
    - *Hold the magnifying glass above the black paper so that the sun's rays are focused on a spot on the paper until a change occurs*.
    - *Students could test the temperature of the paper* with their hands. **Caution - the paper can burn or become extremely hot.**

2. Discuss devices that are used to view the sun *(see Teacher Notes and Debriefing):*

    - *sun cameras*
    - *# 14 welders glass*

Teacher's Notes and Debriefing:

The sun in the closest star to the Earth. Like other stars it gives off intense heat and light. The light from the sun is so bright that looking at the Sun without proper eye protection will permanently damage the eyes. The magnifying lens used in the demonstration is similar to the lens of the eye which also focuses the light making it intense enough to cause permanent eye damage. **It only takes 3 seconds! There are no pain receptors in the retina of the eye so there is no pain to warn us of the damage being done.**

Cloudy days are not safe either because of ultraviolet rays. The sun can be viewed indirectly with the use of certain devices. Students can build a Sun or pin hole camera.

The students stand with their backs to the Sun and hold the camera over their heads with the pin hole pointed towards the Sun. The image of the Sun should fall on the white paper taped to the inside of the box. Students may view the Sun directly through #14 welder's glass (available from welder's supply). **Do not substitute – two #7's. They do not provide the same protection as one #14.** Special filters for telescopes may provide protection while viewing the Sun but good filters can be very expensive and the efficacy of the cheaper ones is questionable.

Activity: Pinhole Camera

Students review the importance of never directly viewing the Sun and will construct a pinhole camera for safe viewing.

Materials:

shoebox
pin
sheet of white paper
tin foil
tape

Procedure:

1. Cut a 5 cm square out of one end of a shoebox.

2. Cover with a piece of tin foil. Tape into place making sure the tin foil is flat.

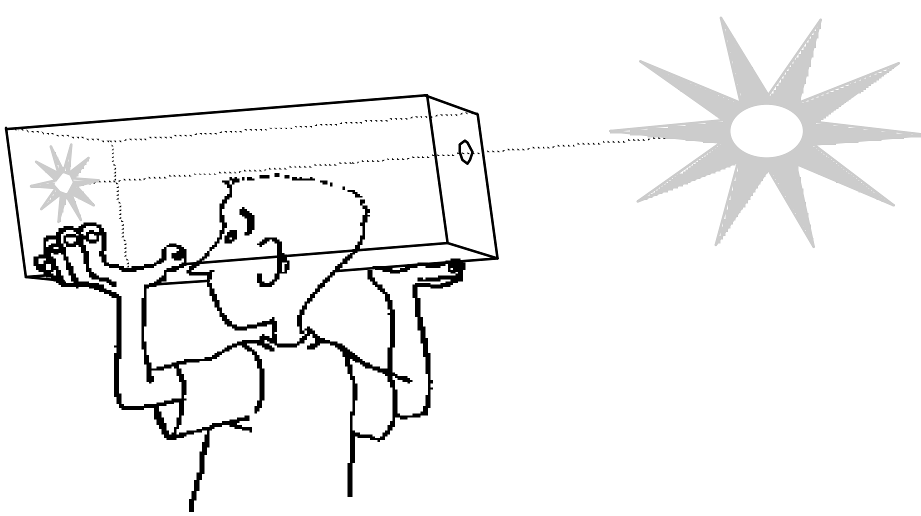
3. Poke a small hole in the center of the tin foil with a pin.

4. Place a sheet of white paper on the inside of the box at the opposite end.

5. To view, hold the box above your head with the pinhole facing toward the eclipse. You will face the screen with your back to the eclipse. An upside down image will form on the screen.

Teacher's Notes and Debriefing:

The pinhole camera is a simple and safe way to view an eclipse of the Sun. Students should be reminded that viewing the Sun can be dangerous and proper precautions must be taken.



Activity: Casting Shadows

This activity helps students understand the relationship between shadows and the Earth's rotation on its axis. It also provides an answer to the question below.

Question:

Does the length and position of shadows change throughout the day?

Materials:

globe
light source
meter stick
ruler *(30 cm)*
plasticine
toothpick
chalk
felt marker *(for each pair of students)*
long sheet of rolled paper
Masters #9a and #9b

Procedure:

1. Stick a piece of plasticine on the globe at the spot where Edmonton is located and stick a toothpick into the plasticine.

2. Demonstrate day and night by shining a light on the globe while the globe is being turned. Follow the piece of plasticine around during one complete revolution. Students should note the length of the shadow cast by the toothpick as the Earth rotates.

3. Discuss the apparent movement of the sun as being related to the actual movement of the Earth's rotation. The students should be able to:

   - *Explain how a shadow and the Sun are related.*
   - *Predict the time in the day when the Sun casts a very short shadow.*
   - *Explain why the shadow is not in the same place or same length every day.*
   - *Predict the location of the Sun by viewing the position of the shadow.*

4. Demonstrate how to set up a meter stick to measure the length of a shadow over the course of a day. See the diagram on Master #9b.

   - *Pass out recording sheets (Master #9a).*
   - *Have student pairs go outside preferably on a paved area with their materials.*

- *Students place the ruler upright in plasticine so that it is perpendicular to the ground.*

- *Student should outline the end of their metre stick on the pavement with chalk to ensure that the stick will always be placed in the same position for every reading.*

- *Students should use chalk to outline the position that the paper will be placed on the pavement. Allow for plenty of room between student pairs as the shadows tend to grow and change direction.*

- *Students will begin their first observation by outlining the shadow cast by the stick and measuring the shadow in millimeters using the second meter stick or a ruler. Record data on Master #9a.*

- *Student pairs are to be sent out at various intervals throughout the day to observe and record shadow length.*

Teacher's Notes and Debriefing:

Master #9b has been included as a sample of the data that could be collected (for teacher information). Students could use the data provided in the table to complete the graph on the bottom of the page.

The length of the shadow depends on the position of the Sun in the sky. In the morning the Sun is low in the East. The shadow should be relatively long and extend away from the Sun. As the Earth rotates the Sun appears to move across the sky. As the Sun moves to an overhead position (noon) the shadows cast become shorter. In theory when the Sun is directly overhead there is no shadow at all. Distances north and south of the equator determine how much shadow is seen at noon. As the Earth continues to rotate the Sun appears to move to the West and the shadows become longer and longer until the Sun sets. The only time that the Sun will be directly overhead at the edquator will be on the equinox days. On those two days there should be no shadow at all. That is the definition of equinox.

The apparent movement is due to the Earth's rotation and can be explained in the fashion the Galileo used to explain why he thought the Earth went around the sun as opposed to the Sun going around the Earth. *When you stand on shore and watch a boat pull away you think that the boat is moving away from the shore, but the shore could be moving away from the boat.* Another experience your students may have had is sitting in a car stopped at the lights. As the car next to you moves forward and even though you are stopped you have the sensation that you are moving backwards.

What keeps the planets moving around the Sun? Or the Moon around the Earth? Why Don't the planets fall into the Sun, or fly off into space?

- Objects in space attract one another with a force known as *Gravity*. The sun, for example, pulls the planets toward it with a gravitational force that gets stronger as you approach the sun. However, the planets also pull the sun towards them, but this pull is not as effective because the planets are so much less massive than the sun. The planets do not fall into the sun because of their tremendous orbital speed. This velocity balances the gravity of the sun so that the planets are forced to move in near–circular orbits around the sun. The same applies to moons moving around a planet.

Activity: Shadow Graph

Students can infer the Sun's apparent movement by graphing and interpreting data collected using the shadow stick.

Materials:

Masters #9b and #10

Procedure:

1. Students should construct a bar graph using their information from the previous activity (measured lengths of shadow (*responding variable*-y axis) and time recorded (*manipulated variable*-x axis). Complete Master #9b if not don in the previous activity.

   - *responding variable (y-axis) - measured length of shadow*
   - *manipulated variable (x-axis) - time recorded*

2. Students answer questions on Master #10 by interpreting their graph.

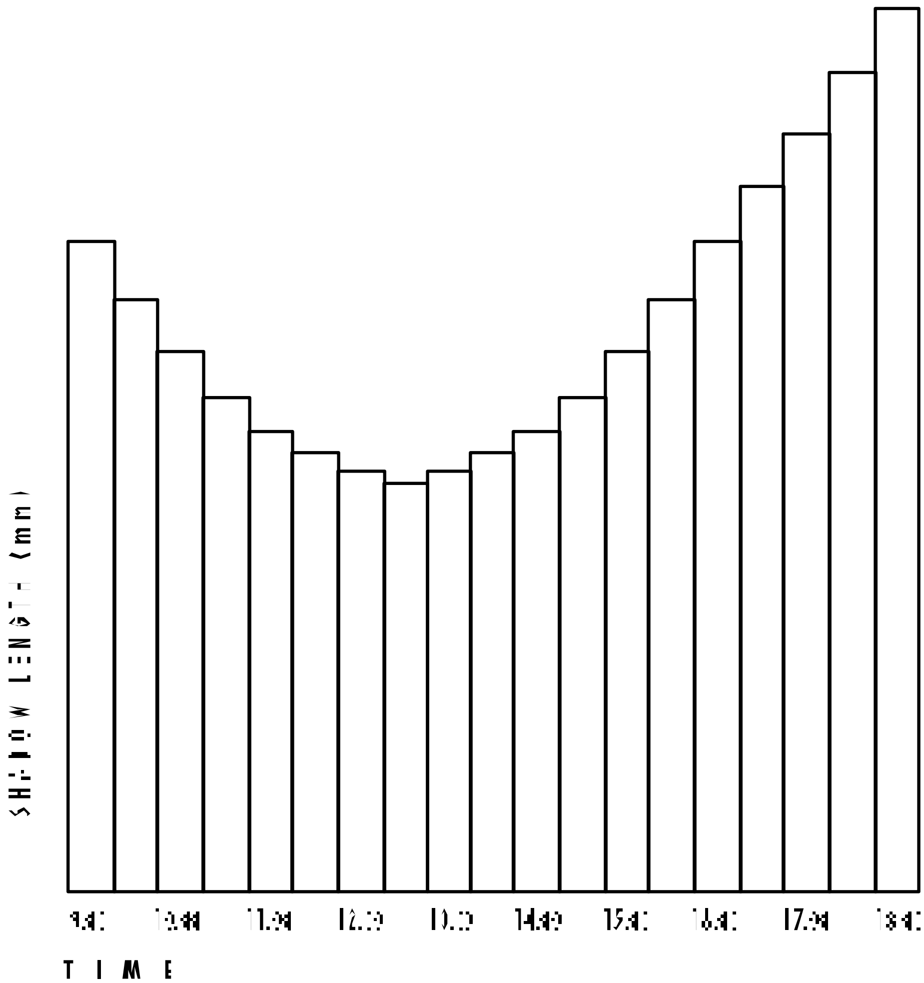
Teacher's Notes and Debriefing:

Solar noon is the time of day when the shadow that the Sun cast is the shortest and points directly north. The shadow will be longest early and late in the day, so this activity needs to be started *early* and carried on *throughout* the day. Student observations should be conducted at shorter intervals between 11:00 a.m. and 1:00 p.m. to assist students in determining Solar Noon (*High Noon*). For question #4 on Master #10, students are expected to collaborate to determine the answer.

Discussion should include:

- *What is a shadow?*
- *Do we always have a shadow?*
- *How does our shadow change during the day? (morning, afternoon, evening)*
- *How does the length and position of the shadow change during the day?*
- *Describe the pattern or trend observed in your graph?*
- *What is the relationship between the position of the Sun and length of the shadow?*

Possible graph:



From early morning to noon, our shadows shorten slightly. From noon until evening, our shadows lengthen. This is most noticeable during the summer months because the Sun is higher in the sky.

Activity: Make a Sundial

Task: Using shadows to tell time.

Materials:

manila tag
scissors
Masters #11a and 11b
glue
cardboard (*or Bristol board- thick)*

Procedure:

1. Glue the paper with the triangle pattern found on Master #11a to a piece of manila tag Cut out the triangle shape.

2. Cut out the semi-circle shape found on Master #11b and glue this to a thick cardboard base (25 X 15 cm).

3. Fold the triangle along the dotted line and glue the folded strip to line A on the semi-circle. Matching point A on the triangle to point A on the semicircle.

4. Use a compass to determine directions. You need to find north and south.

5. Take the sundials to a sunny area and place them on a flat surface with the triangle pointing north-south. The tall end of the triangle will face north and the small end will face south. See diagram below.

6. Mark the position of the shadow on the base every hour and record the time.

7. On a sunny day students will now be able to tell the time by using their sundial.

Teacher's Notes and Debriefing:

You will find that if you mark the shadows every hour, the distance between each of the markings will be the same, since the sun moves across the sky at a steady rate. The actual position of the shadow for a particular time will vary between seasons and latitude due to the relative difference in the position of the sun. The sun is higher in the sky in summer than in winter. The sun is also higher in the sky as you move closer to the equator. The angle on the south end of the triangle is 53.5° which is our latitude in Edmonton. This angle needs to match the latitude of your location. Why?

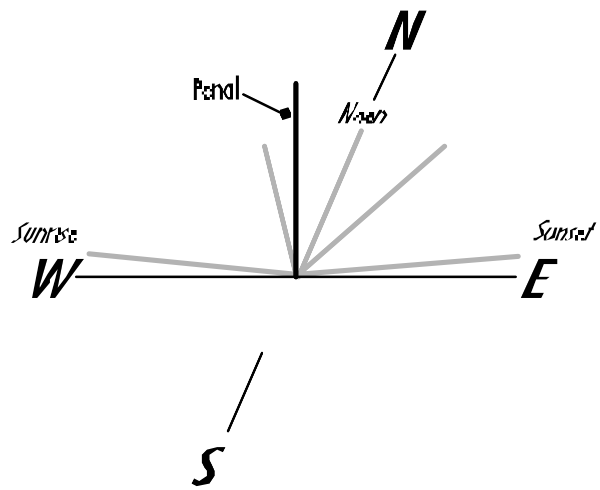
SLE 5: Construct a device for plotting the apparent movement of the Sun over the course of the day.

Activity: Sundials

In this activity students construct a device that uses a shadow to tell the time.

Materials:

pencils *(to use as small shadow sticks)*
plasticine
rulers
graph paper
fine tip markers
Master #11 *(overhead)*



Procedure:

1. Display one each of the following*: pencil, graph paper, plasticine, ruler* and *marker*. Ask the students how they could make a “clock” that uses shadows to tell the time.

2. Students should be encouraged to:

   - *Determine the constant variables (length, thickness and position of the shadow stick).*
   - *Determine the responding variable (shadow of the stick).*
   - *Determine the placement of their “dials” either in a sunny window or outside.*
   - *Determine an appropriate time interval to calibrate the sun dial and mark off the times.*

3. Students will construct the sundial and begin the calibration (mark the times).

4. Display overhead of Master #11. Students should discuss and compare Ancient clocks with their constructed sundials (see *Teacher’s Notes and Debriefing*).

Teacher's Notes and Debriefing:

People have always been fascinated by the Sun; observing, wondering, even worshipping it. Early people created stories to explain why the Sun rose in the east, traveled across the sky and set in the west. Ancient civilizations not only observed, they also used the Sun to tell time.

The Sun's regular movement enabled people to determine the time based on the shadows that were cast during various times throughout the day. *Sundials* are instruments that are used to tell time. By constructing their own sundials, students are utilizing the apparent regular and predictable movement of the Sun.

There are two common misconceptions that children often have in regards to the night sky.

- The Earth remains stationary and it is the objects in the sky that move.
- During the different seasons the Earth moves closer and farther away from the Sun.

SLE 6: Describe the seasonal changes in the length in the day and night and in the angle of the sun above the horizon.

Demonstration: Sun Shines

This activity is to demonstrate that the angle at which the sun shines determines the amount and intensity of light.

Materials::

flashlight
globe
chalk

Procedure:

1. Describe the *equator* and the *hemispheres*. Ask you students, *Why do you think there are seasons?* This can lead to an interesting discussion. Let any and all suggestions stand for discussion. *Why is it hot in the summer and cold in the winter?* Get your students to describe the four seasons in terms of the amount and type of precipitation; temperature and length of day.

2. The teacher holds a flashlight so that it shines directly on the globe.

3. Use chalk to outline the "circle of light" that is formed on the globe.

4. Holding the flashlight at the same distance as in step #1, tip the flashlight on an angle so that it shines on the same spot, but at a slant.

5. Use chalk to outline the new "circle of light" that is formed on the globe.

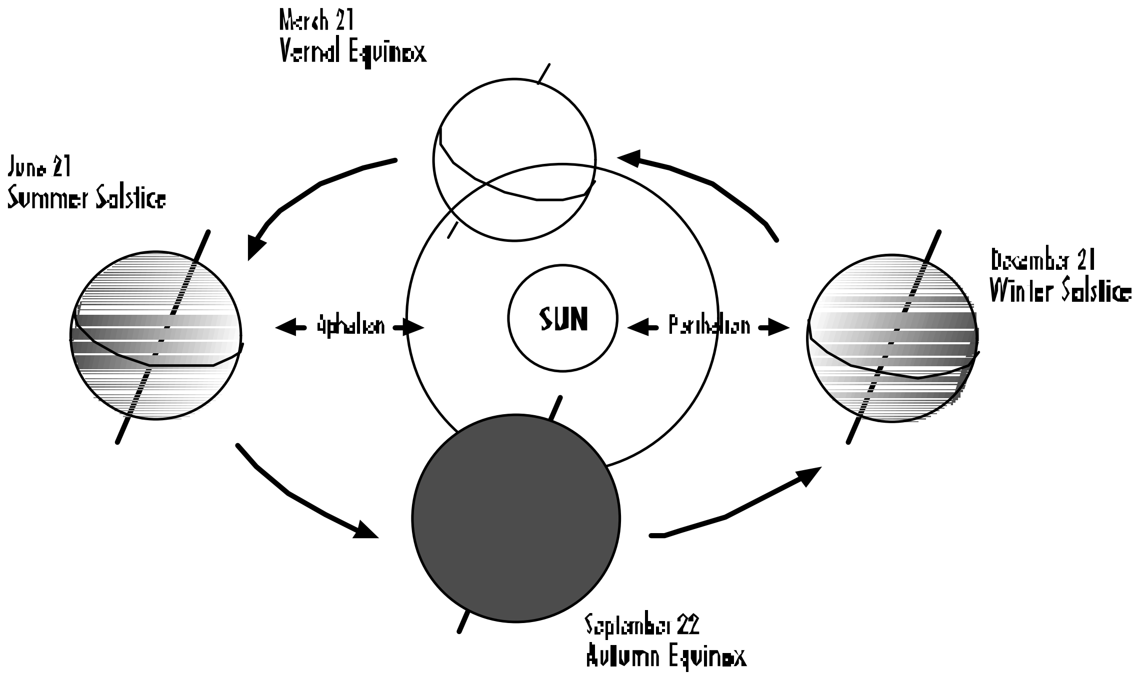
6. The students should observe the two "circles of light", and be encouraged to:

   - *Explain the reasons for the differences in sizes of "circles of light".*
   - *Explain the relationship of energy/heat generated from the focused light and the spread light to the angle of the Sun's rays.*

Teacher's Notes and Debriefing:

The concepts in this activity are covered in the Grade 5 Weather unit. Because the Earth's axis is tilted, rays of sunlight are more direct and are pre slanted during the winter. This causes differences in the amount of daylight and temperature in the seasons. The Earth is tilted 23.5° on its axis. This tilt and the orbiting of the Earth around the Sun causes the seasons.

The Sun radiates a tremendous amount of heat and energy. Energy from the Sun is called *solar energy*. In recent years, scientists have discovered ways to store and use solar energy, in some cases replacing electrical and fossil fuel sources of energy.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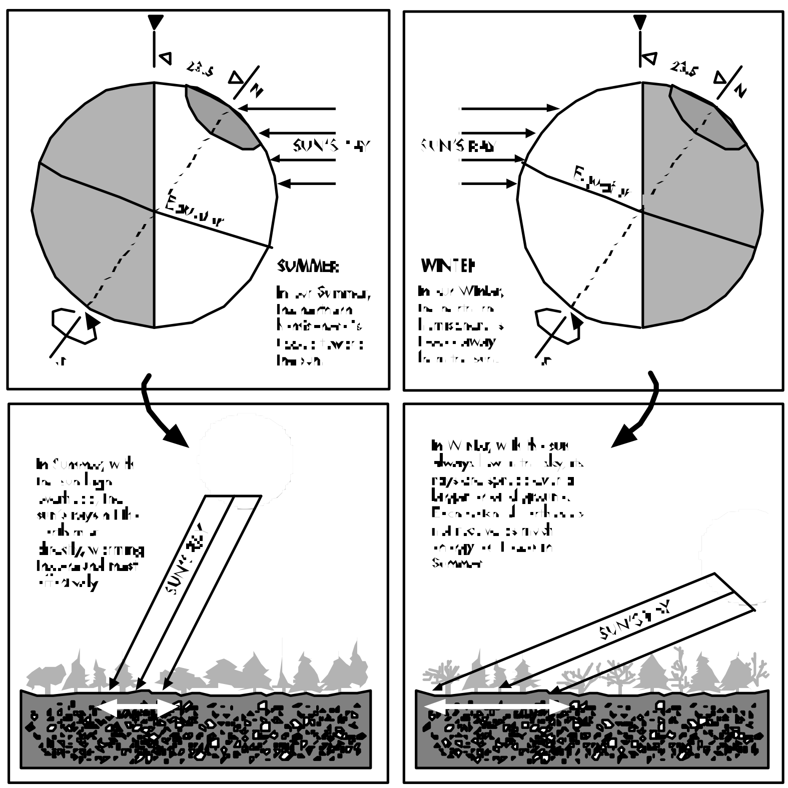
Vernal Equinox
June 21
Summer Solstice
December 21
Winter Solstice
Aphelion
SUN
Perihelion
September 22
Autumn Equinox


23.5
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SUMMER
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Activity: The Reasons for the Seasons

Students discover that the seasons are due to the tilt of the Earth's axis and the way in which the Sun's light strikes the Earth as the Earth orbits the Sun

Materials:

globe
lamp with bright bare bulb *(Sun)*
plasticine
overhead of Master #12a, #12b and #12c

Procedure:

1. Discuss the four seasons regarding relative temperatures, relative length of day, climate, and dates of solstices and equinoxes. Chart this information.

2. Students should be encouraged to:

   - *Make generalities about the seasons (e.g. summer has more daylight and hotter temperatures).*

   - *Hypothesize why these conditions occur.*

3. Set up a model of the Earth and the Sun:

   - *Put a lamp in a spot where you are able to walk around it carrying the globe.*

   - *Ensure that the globe is tilted 23.5 degrees, and remind the students that the Earth stays tilted in the same direction as it orbits the Sun.*

4. Display the overhead of Master #12c. Students should be encouraged to:

   - *Discuss the implications of the tilting*.

   - *Relate the angle of the sun to the seasons*.

   - *Predict what the seasons would be like if the Earth was not tilted, or if the Earth was more tilted?*

5. Using plasticine, mark four equidistant points around the globe from the equator the first of which should be on the *Tropic of Cancer*. This is a line at the southern tip of the Baja Pennisula.

   - *Hold the globe so that the Northern Hemisphere is tilted towards the Sun and explain that on or about June 21 the direct rays of the Sun fall on the Tropic of Cancer. This is the longest day of the year for us and is called the* ***Summer Solstice****.*

- *Walk the globe, counterclockwise, a quarter of the way around the Sun - keeping the tilt of the Earth the same- you should be at the second piece of plasticine. The direct rays of the Sun fall on the Equator. This happens on or about September 21st and is known as the Autumn or* ***Fall Equinox****. There is an equal amount of daylight and darkness at the equator on the day of the Equinox.*

- *Walk the globe another quarter of the way around the Sun. You should be at the third piece of plasticine. The Southern Hemisphere should be tilted towards the Sun. This is the shortest day of the year for us. This happens on or about December 21st and is called the* ***Winter Solstice****. The direct rays of the Sun fall on the Tropic of Capricorn. (This line is near Rio de Janero, Brazil.)*

- *Walk the globe another quarter of the way around the Sun. You should be at the fourth piece of plasticine. The direct rays of the Sun, once again, fall on the Equator. This happens on or about March 21st and is known as the* ***Spring or Vernal Equinox****.*

- *Walking another quarter of the way around the Sun brings you back to where you began, the Summer Solstice.*

Teacher's Notes and Debriefing:

Please note that in Learner Expectation #6 students need to be able to describe the seasonal changes in the length in the day and night and in the angle of the sun above the horizon. In this activity the terms equinox and solstice are introduced however, students do not need to know these terms.

As the Earth orbits the Sun, the direct rays of the Sun fall between the Tropic of Cancer in the Northern Hemisphere and the Tropic of Capricorn in the Southern Hemisphere. Twice each year, the rays of the Sun fall directly on the Equator. On these days there is equal amounts of day and night at the Equator. These occasions are called the "Equinoxes." When the Sun's rays fall directly on the Tropic of Cancer it is the Summer Solstice in the Northern Hemisphere (usually on or about June 21st). When the suns rays fall directly on the Tropic of Capricorn it is the Winter Solstice in the Northern Hemisphere (usually on or about December 21st).

Master #12a is provided for student and teacher information.

Actually the cause of the seasons can be attributed to the tilt of the earth's axis. The axis around which the earth rotates every day is tipped 23.5° with respect to the plane of the earth's axis is always pointed to the same spot in space (very near the North Star), so that during the year the Northern Hemisphere where we live is alternately tipped toward and then away from the sun. When it is tipped toward the sun, the sun's rays beat down upon the earth from almost straight overhead. Each given patch of earth receives the maximum amount of solar radiation, or conversely, a given amount of solar heat is distributed over the smallest area.

But in winter, the Northern Hemisphere is tipped away from the sun. The same amount of solar radiation we were receiving six months before is now spread over a much larger area of earth. Each given area of land receives far less heating than it would during summer.

The tilt of the earth's axis contributes to the seasons in two ways:

Firstly, it causes the sun to change in altitude throughout the year. If you were to plot the position of the sun at noon for each day of the year, you would find that the sun reaches its highest noon–day altitude on June 21st. Its lowest noon–day altitude is reached on December 21st. While proceeding from one extreme to the other, the sun passes through a mid-way point twice a year. These are the two equinoxes of March 21st and September 22nd. From our latitude to Edmonton, the sun is 36.5° above the southern horizon on the equinoxes, 60° above the horizon at summer solstice and 13° high at winter solstice. Because of this difference is altitude, the sun's rays strike the earth's surface at varying angles during the year. This effect, helps create the seasons. Notice also that if we lived further south, the sun on each of these dates would be higher in the sky. For example, for people living on the equator, the sun is directly overhead at noon on March 21st and September 22nd.

Secondly, the tilt of the earth's axis also causes the number of daylight hours to vary during the year. In summer the sun rises well to the north-east around 5:00 A.M. or so but doesn't set in the north-west till about 10:00 P.M. Combine this with the sun's maximum altitude in summer and it's easy to see why summer days are warmer – during the long summer days the sun has a greater opportunity to warm the earth. In winter, the sun just begins to warm the earth each day when it begins its descent into the south-west to set in the late afternoon. The winter sun never has a chance!

If the longest day of the year is June 21st, then why isn't that the hottest day of the year? Similarly, if the shortest day of the year is December 21st, then why are the coldest days of winter usually in January or February?

- The reason for this effect, called the *lag of seasons*, lies in the fact that the earth and its atmosphere act as insulators. On June 21st, we receive the maximum amount of sunlight in the Northern Hemisphere. As the sun proceeds southwards, the sunlight we receive grows less, but the amount of heat we are losing into space is (for a few weeks) still less than the amount we receive. Therefore, the overall temperature goes up.

In winter, the earth retains heat for a few weeks past the winter solstice, postponing the coldest days till January or February.

"Midnight Sun" refers to places like the Arctic where the Sun never rises or sets.

SLE 7: **Recognize that the Moon's phases are regular and predictable, and describe the cycle of its phases.**

SLE 8: **Illustrate the phases of the Moon in drawings and by using improvised models. An improvised model might involve such things as a table lamp and a sponge ball.**

Activity: Introducing the Moon

Students learn some general facts about our closest neighbor in space.

Materials:

cantaloupe
globe
library books on the moon
ping pong ball
felt marker
Masters #13 and #14

Procedure:

1. Demonstrate the relative size of the moon by displaying a ping pong ball (the Moon) and a cantaloupe (the Earth) 4.5 metres apart.

2. Demonstrate the revolution of the moon (cantaloupe) around the Earth to explain why only one side of the Moon always faces the Earth. To do this, first place the globe on a small table in the centre of the room Mark a spot on the cantaloupe with a felt pen and then walk around the globe so that the spot always faces the Earth. Notice that the Moon thus must rotate on its axis once as it makes one complete revolution around the Earth.

3. Demonstrate that a small object can block out a much larger object due to perspective (distance). Have students put their thumbs in front of their eyes to block out the cantaloupe, their neighbor or some other large object. Have them note that the ability to block out large objects with their thumb depends on how far away their thumb is from their eye and how far away the object is. This is how a relatively small celestial body can 'eclipse' a very large celestial body such as the Sun.

4. Introduce Master #13 and use of the KWL chart. Then explore information books about the Moon.

5. After viewing resources, students are asked to share orally one interesting fact they have recorded on their KWL chart.

Teacher's Notes and Debriefing:

The Moon revolves around the Earth in a counterclockwise orbit and always has the same side towards the Earth.

The Moon rotates on its axis *relatively slowly* once a month at the same time it is revolving around the Earth once in 27 1/3 days. This is why we never see the dark side of the Moon. See Master # 14.

The moon shows progressively different phases as revolves around the Earth. Half the moon is always in sunlight, just as half the earth has day while the other half has night. The phases of the moon depend on how much of the sunlit half can be seen at any one time. A new moon occurs when we see none of the sunlit half of the moon from the Earth. The face is completely in shadow. In about a week the moon enters the ‘first quarter’, a crescent shaped half circle. (It is called a *quarter* because we see only half of the sunlit half of the moon-half of a half is a quarter). After another week the *full moon* appears. A week after the full moon we see the *last quarter* where the moon appears as a *crescent* once again. The entire cycle is repeated each lunar month. (a lunar month being the time it takes for one entire cycle of lunar phases to occur-approximately 29 days and 12 hours). When the moon is full it is farther away from the Sun than the Earth. When there is a new moon the moon is closer to the Sun than the Earth. When the moon is more than half-illuminated, it is referred to as *gibbous*. As the moon goes from a new moon to a full moon it is said to be *waxing* It is *waning* as it gets smaller going from the full moon to the new moon.

Demonstration: The Phases of the Moon

Question:

What is the order of the Moon's phases?

Materials:

ball
bulb and free standing lamp
Master #15
beach ball
black tape

Procedure:

1. Ask the students about the different shapes of the Moon (that they have seen or observed). Students will typically talk about the quarter, half and full Moon.

2. Have one student stand in the middle of the floor representing the Earth. Ask a second student to move (revolve) around the Earth, always facing the Earth, in a counterclockwise direction. This demonstrates how the Moon moves around the Earth.

3. Next, darken the room and plug in a bulb (represents the Sun – it should be a lamp so the entire bulb is exposed). Ask a student to hold a ball above their head (representing the Earth). Ask a second student to stand on the right hand side of the Earth (representing the Moon). Practice modeling different phases of the moon. Keep in mind that the Moon revolves counterclockwise around the Earth with the same side always facing the Earth.

   - Model a *new moon* (moon appears black): The Moon should be between the Sun and the Earth. Remember that we are looking <u>from</u> the position of Earth <u>at</u> the Moon. The new Moon phase is not visible to us on Earth.

   - Model a *waxing crescent* (small backwards C or thin sliver): The student who is the Moon moves one-eighth of a revolution around the Earth (counterclockwise). Whenever the Moon seems to increase in size it is considered to be *waxing*.

   - Model the *first quarter* (half of the Moon is bright or white): Again, the Moon moves one-eighth of a revolution around the Earth (counterclockwise). It is called the first quarter Moon because the Moon has traveled one quarter of its orbit around Earth.

   - Model a *waxing gibbous* (more than half or three quarters of the Moon can be seen): The Moon again moves one eighth of a revolution (counterclockwise) around the Earth.

   - Model a *full Moon* (the entire Moon or circle is bright): The Moon moves another one eighth of a revolution around the Earth (counterclockwise).

- Model a *waning gibbous* (moon seems to decrease in size): The Moon moves another one eighth of a revolution around the Earth (counter clockwise). *Waning Moons* appear to get smaller or decrease in size.

- Model a *last quarter* moon (backwards version of the first quarter moon)? The Moon moves another one eighth of a revolution around the Earth (counter clockwise).

- Model the *waning crescent* (the Moon appears to be a thin sliver in the shape of C): The Moon moves another one eighth of a revolution around the Earth (counter clockwise).

4. Complete Master #15.

Teacher's Notes and Debriefing:

Encourage students to draw and label the different phases of the moon (beginning with the new moon. See the activity *The Changing Moon* for cut and paste Masters for the Moon's phases.

One way to emphasize that one side of the Moon is always in the dark is to cover half of a beach ball with black tape. The black side of the ball represents the dark side of the moon. As you are walking around the Moon with the beachball ensure that the black side of the ball is always facing away from the Sun.

Instructions for observing the Moon during the daytime:

- *On the average the Moon is visible for 12 hours a day. It rises in the east and sets in the west.*

- *The Moon will rise and set approximately 50 minutes later each day.*

- *To observe the Moon during the day, find out the date of the next full Moon in the local newspaper. Also find the time that the Sun rises.*

- *As the Sun rises in the east, the full Moon will be setting in the west.*

- *One day later, the Moon will set 50 minutes after Sun rise (higher in the sky).*

- *Two days later, the Moon will set 100 minutes after Sun rise (even higher in the sky).*

Activity: The Changing Moon

Question:

What is the order of the Moon's phases?

Materials:

scissors
Master #16a, #16b and #17
glue

Procedure:

1. Remind the students that the Moon revolves around the Earth in a counterclockwise orbit (with the same side towards the Earth).

2. Students should cut out the photographs on Master #16a and assemble them into the correct sequence. At this point the pictures **should not be glued**!

3. Teacher displays correct sequence on board and labels each phase. This information is found on Master #16b.

4. Students check over their work and glue the photographs in correct order and label.

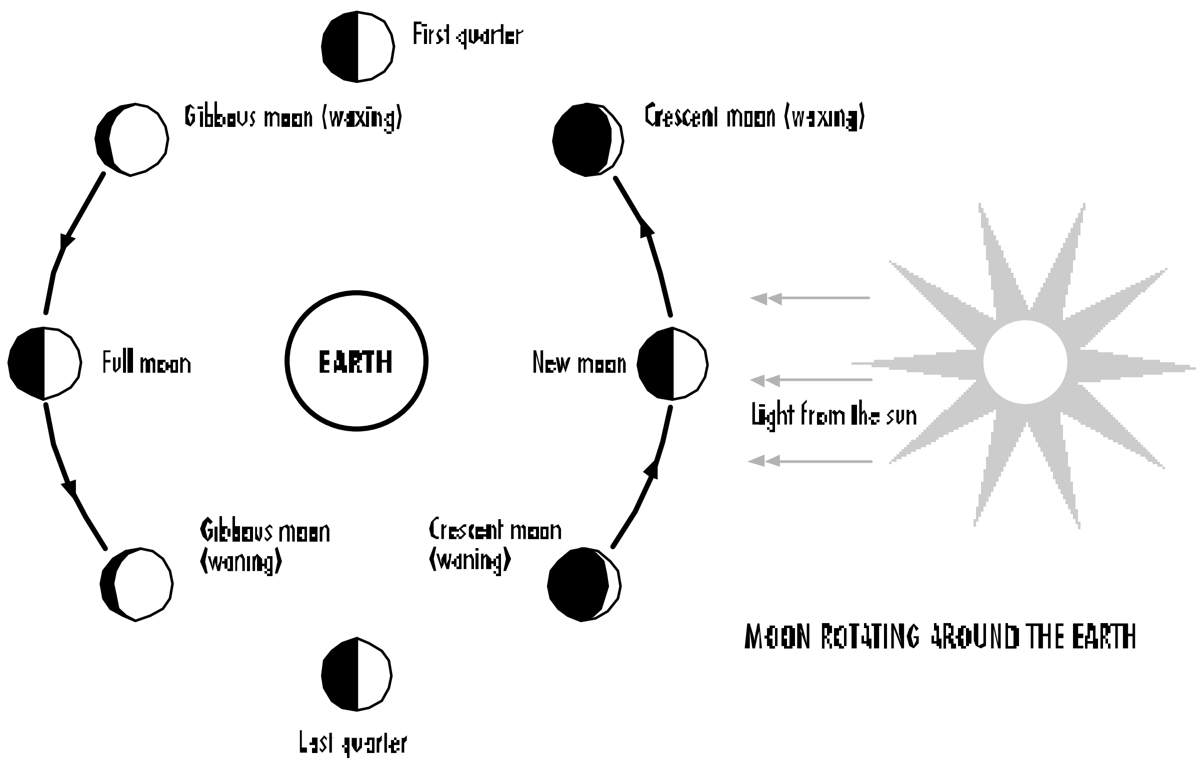
5. Distribute Master #17. Have students cut out along the solid lines and collate the cards according to their numbers. Staple together and fan through the "Flip" book to see the phases of the Moon.

Teacher's Notes and Debriefing:

Students should be familiar with the changes in the Moon as a result of recording their observations on the Moon Recording Sheet (included in the Sky Detective folder) for several weeks. The different shapes of the Moon are called *phases.* A *waxing moon* is when the lightened portion of the moon is growing bigger. A *waning moon* is when the lightened portion is getting smaller. The Moon is the name of the satellite orbiting the Earth. The word "Moon" is capitalized when it is used as a proper noun to name the Earth's satellite. All other "moons" that orbit other planets are satellites and can be referred to by their proper names, or referred to as "moons of a planet" (e.g. moons of Jupiter or Io, Callisto, Ganymede...).

The moon is about one-fourth the size of the Earth. The moon moves in an elliptical orbit, about 400 000 km above the Earth at an average speed of 3700 km per hour. The moon rotates on its axis once in about the same period of time it takes to complete one revolution around the Earth, accounting for the fact that the same portion of the moon is always facing the Earth.

The moon shows progressively different phases as revolves around the earth. Half the moon is always in sunlight, just as half the earth has day while the other half has night. The phases of the moon depend on how much of the sunlit half can be seen at any one time. A new moon occurs when we see none of the sunlit half of the moon from the Earth. The face is completely in shadow. In about a week the moon enters the ‘first quarter’, a crescent shaped half circle. (It is called a ‘quarter’ because we see only half of the sunlit half of the moon- half of a half is a quarter). After another week the full moon appears. A week after the full moon we see the ‘last quarter’ where the moon appears as a crescent once again. The entire cycle is repeated each lunar month. (a lunar month being the time it takes for one entire cycle of lunar phases to occur-approximately 29 days and 12 hours). When the moon is full it is farther away from the Sun than the Earth. When there is a new moon the moon is closer to the Sun than the Earth. When the moon is more than half-illuminated, it is referred to as *gibbous*. As the moon goes from a new moon to a full moon it is said to be *waxing*. It is *waning* as it gets smaller going from the full moon to the new moon.



Activity: Moon Dance

Students explain the phases of the moon by making and using a model.

Materials:

free standing light source
pencil
felt pen
Masters #18a, 18b and 18c
Master #1
tennis ball
yellow felts/crayons
overhead of Master #18a
overhead of Master #18b

Procedure:

1. Place materials on the table for the class to view or provide groups of students with various materials.

2. Ask students how these materials could be used to set up a model to show the Moon's changing appearance.

3. Allow time for the students (in small groups) to develop their own model and observe the phases.

4. As their model is developed the students should be encouraged to:

   - *Explain why the same side of the ball always faces the light source*.

5. Teacher now uses the materials to demonstrate while students complete Master #18a. An overhead of Master #18a should be displayed simultaneously.

6. A selected student, acting as a model, completes the overhead Master as remaining students complete Master #18a at their desks.

7. Students should be encouraged to:

   - *Identify the correct name of each phase of the moon.*
   - *Predict the appearance of the lightened phase before the teacher moves the model to the next phase*.

Teacher's Notes and Debriefing:

Explain to the students that astronomers often set up models to help them understand the effect of movement of related objects (i.e. Moon, Earth, Sun). The light source would represent the Sun; the ball, the Moon and the student, the Earth. The student should stand in front of the light source. The ball should be held at **forehead level** and **outstretched** as the student turns slowly counter **clockwise**. As many students as possible should be allowed to manipulate the model as other students observe the phases.

For this concept, repeated observation is necessary. Students should have been provided with copies of Master # 1 (Moon Recording Sheet) at the beginning of this unit as it is best if the students have some background before attempting this activity. Their Moon Recording sheets should be brought back to school at this time in order for them to compare. Depending on the nature of the class the teacher may want to show the relationship between the dark side of the Moon (Master #14) and the phases of the Moon (Master #18a) by showing Master #18c. Several Masters require students to draw, rearrange and label the phases of the Moon. This is a difficult concept for many students.

SLE 9: Recognize that the other eight known planets, which revolve around the Sun, have characteristics and surface conditions that are different from the Earth, and identify examples of those differences.

Activity: Exploring the Planets

Students research and learn about the other celestial bodies in our Solar System

Materials:

reference books
CD-ROMS
pamphlets
various websites on the internet
information books
film strips
pictures
Master #19 and #20

Procedure:

1. Place materials on tables according to the type of media information, books on one table, pamphlets and pictures on another etc.

2. Direct the students into forming categories/questions about planets to guide their research and to organize their information gathering. Record suggestions on the chalkboard. Students should be encouraged to:

   - *Identify general characteristics of planets such as size, length of day, number of moons, color of planet, etc.*

   Master #19 may be used as a possible research sheet.

3. Assign groups of students to a table to <u>explore</u> the resources. The students will rotate to different tables at teacher determined times (e.g. every 15 minutes).

4. Students record questions, interesting facts, and comments on their think pads. Note: As this is time for broad exploration, students <u>should not narrow their focus</u> on a specific planet at this time.

5. Display overhead of Master #20 and explain that this information has been supplied by NASA and is one way of identifying characteristics that they felt were important. Students should be encouraged to :

   - *Identify which categories are similar to theirs.*

   - *Identify which categories they did not include.*

   - *Identify categories they have provided that were not included in NASA's table.*

Teacher's Notes and Debriefing:

This activity prepares the students for the project to be completed later by reviewing and developing their research skills. The following activities help to enhance an understanding of some of the above categories. These activities could be done as demonstrations or set up as centers for student discovery. Students may enjoy making 3-dimensional scale models of the solar system.

The Solar System is made of everything that orbits around the Sun. These include: *asteroids, planets, comets* and *moons*. The nine planets outwards from the sun are *Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.*

From outerspace, the Earth does not look like it does on a map. There are no borders showing where countries, provinces, or states begin and end. There are no labels on any of the land masses or bodies of water. Astronauts are able to point out areas on the Earth because they are familiar with the geography of the Earth.

From space, astronauts see the effects of pollution on the planet. Around some major North American cities, they see smog in the atmosphere. The burning rain forests in the Amazon can be seen from space. Water pollution in some of the rivers of India and China is also visible from space. There is also environmental damage that isn't visible from space, such as holes in the ozone layer. The ozone layer is a thin layer that is part of our atmosphere. This layer is very important because it filters out ultraviolet rays that can cause skin cancer in humans. The ozone layer protects us.

Activity: Distance from the Sun

Students compare the distances of various planets from the Sun.

Materials:

2 metres of string	9 beads
circle of yellow manila tag	metre stick

Procedure:

1. Use the yellow manila tag to represent the Sun and attach it to one end of the string.

2. Mark off 2 cm along the string and make a knot and thread on a bead (Mercury).

3. Mark off 4 cm along the string (always measure from the Sun) and make another knot and thread the bead (Venus).

4. Continue this procedure using remaining beads using the following measurements:

   - *5cm-Earth*
   - *8cm-Mars*
   - *27cm-Jupiter*
   - *49cm-Saturn*
   - *100cm-Uranus*
   - *150cm-Neptune*
   - *200cm-Pluto*

Teacher's Notes and Debriefing:

The bead measurements are approximate. More accurate distances can be found in the table below. The beads and string should give students some appreciation for the relative distances between the planets and the distance that each planet is from the Sun. It may still be difficult for them to comprehend the enormous distances involved. For example Viking probes, launched in 1975, took 11 months to reach Mars traveling at a speed of about 10 000 km/h. Pioneer 10, launched in 1973, is expected to take 80 000 years to reach the closest star.

Activity: Period of Revolution

Question:

Do some planets take longer to revolve around the Sun that others?

Materials:

a chair
3 students
large spacious area

Procedure:

1. Place a chair (*Sun*) in the centre of the room.

2. Assign a student (*Mercury*) to stand about arm's length from the chair.

3. Assign another student (*Earth*) to stand about 2 to 3 metres from the chair.

4. Assign the third student (*Pluto*) to stand as far away from the chair as the room permits.

5. Make sure the students (*planets*) are aligned and have them begin walking at the same speed around the chair (*Sun*).

6. Encourage the students to :

   - *Identify which student (planet) took the longest time to revolve around the chair (Sun).*

   - *Identify which student (planet) took the shortest time to revolve around the chair (Sun).*

   - *Relate the distance the planet is from the Sun to the period of revolution*.

   - *Determine where they prefer to live if they liked birthday cake--Pluto or Mercury*.

Teacher’s Notes and Debriefing:

A year can be defined as the time it takes for a planet to make one revolution around the Sun.

The Earth takes 365 1/4 days to revolve around the Sun. A *leap year* is the adjustment of the 1/4 day and occurs every 4 years.

Planet	**Period of Revolution** *(24h days-365.3 days/ year)*
Mercury	88 days
Venus	224.7 days
Earth	365.3 days (1 year)
Mars	687 days
Jupiter	11.86 years
Saturn	29.46 years
Uranus	84 years
Neptune	165 years
Pluto	248 years

The speed of the Earth’s motion and the gravitational pull of the Sun on the Earth keeps the Earth in orbit around the Sun. Satellites with a fast orbit are close to the Sun. Satellites which revolve slowly are farther away from the Sun.

Activity: Fruity Planets (Equatorial Diameter)

Students compare the relative sizes of the planets

Materials:

apple seed
watermelon
orange
small green grape
currant
pumpkin
grapefruit
black grape
raisin
laminated labels of the planet names *(Master #21)*

Procedure:

1. Students should arrange the fruit on order of size.

2. Using the information below, the students identify which fruit represents which planet and label accordingly.

Teacher's Notes and Debriefing:

This activity will help the students visualize relative size of the planets. Use the following table as a guide.

Fruit	Planet
pumpkin	Jupiter
watermelon	Saturn
grapefruit	Uranus
orange	Neptune
black grape	Earth
small green grape	Venus
sultana raisin	Mars
currant	Mercury
apple seed	Pluto

Students may also want to compare the relative sizes of the various satellites that orbit the planets. They may find that there are satellites that are larger than some planets.

Activity: Life on Other Planets

Students undertake, through different activities, to describe what conditions exist on other planets.

Materials:

resources *(see Activity Exploring Planets)*
manila tag
pencil crayons/felts
legal sized art paper
glue
tape
cartons
recording device *(mindmap, blank* recording sheet, split page, index cards)
postcard
travel brochure/poster
scissors
staples
assorted recycled materials

Procedure:

1. Choosing from the categories developed in the previous activities students gather appropriate information (research) in order to create one of three projects.

    - ***Post Cards****: Students are asked to produce a series of postcards that could be sent from at least 3 other planets. The post card could include a picture, address, and a written description of* <u>*probable*</u> *experiences on that planet (experiences need to be based on plausible events related to characteristics of that planet).*

    - ***Travel Brochures/Poster****: Students are asked to produce a travel brochure or poster that will persuade travelers to visit their planet. This could include alluring pictures of the planet, a description of adventures that could be experienced, and captivating slogans (activities need to be based on plausible adventures related to characteristics of that planet).*

    - ***Making an Alien****: Students are asked to build an alien that is adapted to live on its planet. Structural and behaviour adaptations must fulfill the basic needs of that organism in that planet's environment. To assist students with this project, suggest to students that they make a list of basic survival needs* <u>*after*</u> *gathering information about their planet*.

2. Allow time for student presentations.

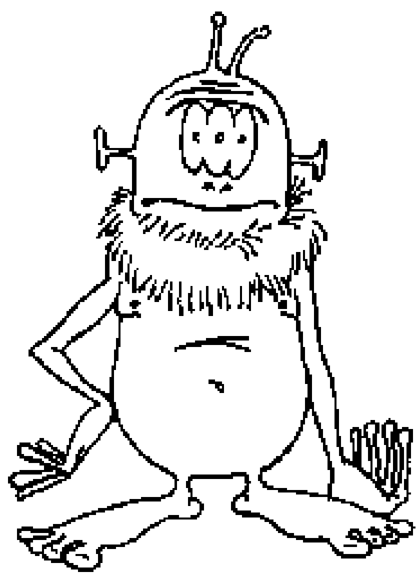
Teacher's Notes and Debriefing:

SLE 9 is presented here as a research project and can take up to 2 weeks to complete. To reduce class time, the students could work on their constructions at home.

Once students have selected their planets, explain that the alien designed should be able to live in the environment of that planet. For example, Pluto is cold and has very limited levels of light. The aliens might be hairy to keep them warm with large eyes to see in the dark. After students have an idea of what their aliens will look like they can draw them or better yet, make models of them.

Space exploration has many problems. These include:

- *no air to breath*
- *no gravity (weightlessness)*
- *cold (-250° Celsius)*
- *no food or water*
- *very large distances to travel*
- *very expensive (1 kilogram in orbit costs $40000)b*



SLE 10: Recognize that not only the Earth, but other planets, have moons, and identify examples of similarities and differences in characteristics of those moons.

Activity: Satellites

Question:

Through this activity students discover the similarities and differences in characteristics of satellites (Moons).

Materials:

text, computer and video resources
Master #22 *(student copies and overhead)*

Procedure:

1. Have students use available resources to discover the features of the other satellites (moons) in our solar system. See the bibliography for suggestions.

2. Guide the students into identifying categories or features of satellites. Students should be encouraged to :

   - *Share the information they have gathered from the resources (e.g. Io is red, Ganymede is blue).*

   - *Identify some of the common characteristics of satellites such as colour.*

3. Model the use of the Venn Diagram (see Master #22).

   - *Display an overhead of Master #22*

   - *Select two moons (satellites): i.e. moons of Jupiter.*

   - *Determine common characteristics (e.g. color, size, volcanic activity, temperature, age, orbit, shape, craters, names, composition) needed for comparison.*

   - *Record similarities and differences on a Venn Diagram.*

4. Students will select two moons (satellites) and complete own copy of Master #22 (students may be assigned, or choose moons from different planets or the same planet).

Teacher's Notes and Debriefing:

Recent advances in technology have led to the discovery of many new moons of planets. We now know that there are over 60 moons (satellites) in our Solar System. In 1609, Galileo located Jupiter in his telescope and was surprised to find 4 bright spots of light lined up on either side of the planet. He noticed that these 4 spots appeared to be changing location night after night. He predicted that these were probably not stars because stars never change their position in relationship to each other. After further observations, Galileo noted that as Jupiter slowly moved across the sky, these 4 spots moved with it. Galileo continued recording his observations. We now know these to be four of the sixteen satellites of Jupiter referred to as the Galilean satellites. They are Io, Europa, Ganymede and Callisto. The 12 smaller satellites of Jupiter range in size from 8-98 km in diameter. Some were discovered as recently as 1979.

(The term Moon applies to the satellite of the planet Earth only- it is incorrect to use the term when referring to the satellites of other planets).

SLE 11: Identify technologies and procedures by which knowledge about planets and other objects in the night sky have been gathered.

Activity: Time Line

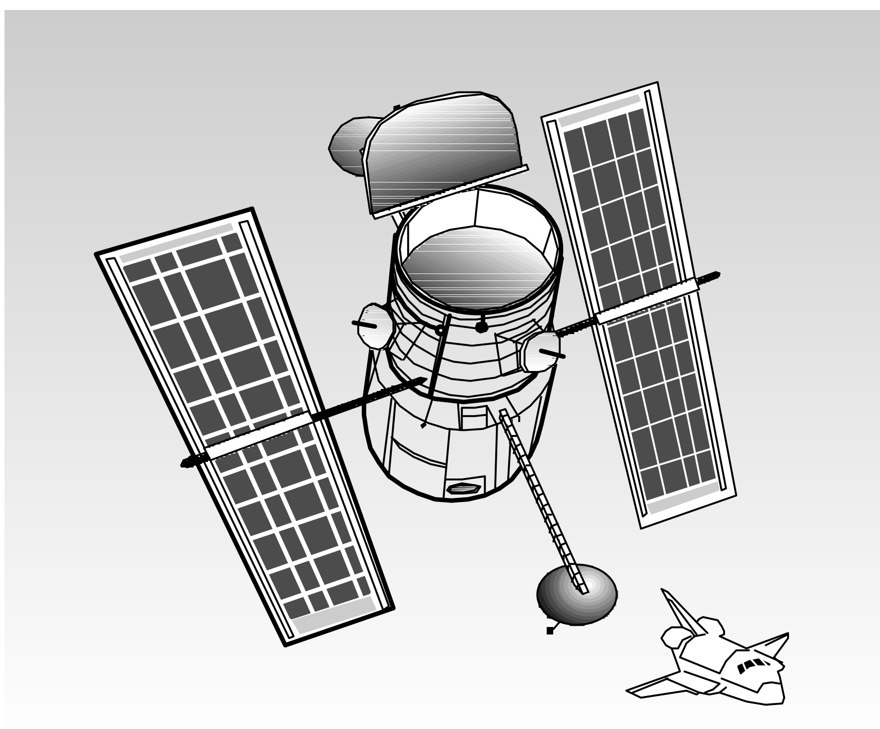
Students discover how theories about our solar system and the universe evolved as space technology developed.

Materials:

CD ROMS
reference materials
metre stick
resources
long sheets of rolled paper
fine tip marker

Procedure:

1. Groups of students work collaboratively to make time lines depicting the development of space technology and the evolution of theories about space and the universe, from ancient times to present.
   - *Assign students to work in groups and allow time to view resources and collect data.*
   - *Groups share their information.*
   - *Students will use the long white paper to construct a time line that will accommodate all of their findings*. Ensure that the information is dated.



Teacher's Notes and Debriefing:

The long sheet of paper should not be marked at regular intervals before data entry, because the spaces between events can vary considerably (i.e. centuries can go by, yet many developments may occur in a single decade). As well, it is important to include the theories of Thales, Greek philosopher from the 6th century B.C. and Ptolemy from the 2nd century, Copernicus from the 16th century, and Galileo and Kepler from the 17th century. The theories of these great astronomers have contributed to our understanding of the universe. Physicists and mathematicians such as Isaac Newton were also instrumental in laying the foundations of astronomy.

SLE 12: Understand that the Earth, the Sun and the Moon are part of a solar system that occupies only a tiny part of the known universe.

Demonstration: Spiral Galaxies

Students learn about galaxies and their motion.

Materials:

sink or wide basin
water
one piece of “hole punch” confetti
overhead of Master #23
stopper
pinch of glitter
wooden spoon

Procedure:

1. Prior to the lesson, put the stopper in the sink and fill sink with water.

2. Display overhead of Master #23 and give a brief introduction about the galaxies (see *Teacher’s Notes and Debriefing*).

3. Remove the stopper (or stir water vigorously in basin with wooden spoon) and encourage students to:

   - *Observe and describe the motion of the water as it runs down the drain (or is stirred).*
   - *Identify which part of the “spiral whirlpool” is moving the fastest and slowest.*
   - *Compare the appearance of the “spiral whirlpool” to the spiral galaxy overhead on Master #23.*

Teacher's Notes and Debriefing:

A *galaxy* is a spiral island of stars in space. Our Sun belongs to the spiral galaxy known as the *Milky Way*. Although our galaxy is immense it is only one of about 30 nearby galaxies called the Local Group. Our galaxy has three spiral arms that rotate around the centre (nucleus). We (our solar system) are located at the inner edge of one of the arms (Orion Arm) 30 thousand light years away from the galaxy centre. It takes the Sun 225 million years to make the long voyage around the centre of the galaxy pulling Earth and the rest of our solar system along with it. Scientist use light-years to measure distances in space as the distances are too large to measure in Earth's terms. A light-year is about 10 trillion km --the distance that light travels in one year. We are a minute part of something massive, complex and spectacular.

It may also be important at this point to briefly discuss speed of light at 3000,000 km per second and that to put into perspective it takes light just over 1 second to read the Moon and 8 $^{1}/3$ minutes to reach us from the Sun. Then explain that the closest star to us is 4.2 light years away.

The *Milky Way* was named when early astronomers looked up at the night sky and saw a milky band of dim stars going across the sky.

Demonstration: Expanding Universe

Students develop an understanding of the theory of the inflating universe.

Materials:

large round balloon
felt tip pen

Procedure:

1. The teacher should partially inflate the balloon *(universe).*

2. Draw several spots *(galaxies)* with the felt marker on the balloon surface.

3. Teacher should continue inflating the balloon. Students should be encouraged to :

    - *Observe the movement of the spots (galaxies) as the balloon (universe) inflates*.

    - *Infer the evolution of our universe by relating the movement of the dots on the balloon to the universe*.

Teacher's Notes and Debriefing:

Astronomers theorize that the universe is still expanding and that the galaxies are moving away from us (our galaxy) and each other. The universe is immense and made up of billions of galaxies, all swirling, all in motion. Due to enormous distances, we may still be seeing stars that have "died" because it takes so long for their light to arrive. A star 'dies' when its fuel is exhausted. The star collapses on itself and forms either a white dwarf star or a neutron star. If there is enough mass and the collapse continues a *black hole* may form. A black hole is sometimes referred to as a *singularity*, a dimentionless object of infinite density. They are so dense that electromagnetic radiation cannot escape from its vicinity.

Activity: Is Anybody Out There?

Students learn <u>*exactly*</u> *where in the universe they live.*

Materials:

envelopes
letter writing paper
pens

Procedure:

1. Teacher leads discussion about life on other planets as depicted in science fiction books *(see Bibliography)*, movies and TV shows.

2. Students write a short message (composed of questions, descriptions of themselves and feelings about space).

3. Students address envelopes to some point outside of our solar system, <u>and include their return address on the back of the envelope</u>.

   - *Student's Name*
   - *street address*
   - *City, Province*
   - *Canada (postal code)*
   - *North America*
   - *Earth*
   - *Solar System*
   - *Orion Arm*
   - *Milky Way Galaxy*
   - *Local Group*
   - *Universe*

Teacher's Notes and Debriefing:

Students can be reminded of the fact that in previous centuries, messages were sent in bottles across the sea. To these people it was like sending messages out to another world.

Students may also enjoy collaborative decision making project:

NASA has been asked the government for funding to design, construct, and launch into Earth orbit a Large Space Structure (*Space Station Freedom*) You work on one of the NASA decision making teams. Your assignment is listed below. Congratulations and good luck!

- **Design, construct and place your structure into space**. Your report should include a labeled drawing and description of the structure, shape, and its features. Materials used in construction must be included. Also include a step by step report on how the structure will be placed in space. Include where it should be placed. Include any other pertinent data.

- **Staffing of Space Station Freedom**. Your task is the selection of a group of people to occupy the space station and an explanation as to why these people were selected. You will only be able to select 10 people to staff the station in the beginning. Please list them and give reasons for their selection.

Potential Personnel		
• Doctor	• Communication expert	• Janitor
• Nurse	• Minister	• Astronomer
• Lawyer	• Politician	• Geologist
• Teacher	• Astronaut	• Meteorologist
• Cook	• Mechanical engineer	• Rocket expert
• Military	• Administrator	• Mathematician
• News media representative	• Fire fighter	• Director of entertainment
• Librarian	• Psychiatrist	• Historian
• Police officer	• Pharmacist	• Mechanic
• Computer expert	• Aeronautical engineer	• Others

- **Function/Purpose of the station**. Your duty is to decide what will be the function and purpose of this station in space. Should it be military or a non-military station? Should this station be operated solely by Canadians or should this be an international work station? Your decision must be supported by statements explaining why.

Activity: Conclusion

Students review the major concepts and learnings from the unit.

Materials:

manila tag
student generated questions from *Inquiring Minds Want to Know*
felt markers

Procedure:

1. Students should observe the number of questions that have not been answered. Students should be encouraged to:

    - *Conclude that our knowledge of space is still limited*.
    - *Conclude that as our ideas (theories) and technology develops, our knowledge will increase.*
    - *Conclude that there are many more questions than there are answers.*
    - *Conclude that we are part of something much larger and more spectacular than we can imagine*.

Teacher's Notes and Debriefing:

It is strongly recommended that students participate in a field trip to a planetarium or star theater (*Margaret Ziedler Theatre* in Edmonton at the *Space Sciences Centre*).

EXTENSION ACTIVITIES

Activity: Survival Story-Simulation

Materials:

Master #24a *(student copies)*
Master # 24 *(overhead)*

Procedure:

1. Teacher should group students (pairs) and hand out copies of Master #24a.

2. Teacher and students should read the "story" at the top of Master #24a.

3. Student groups should rate items listed on Master #24a in terms of importance for survival. *(1-most important to 15-least important).*

4. After designated amount of time, students will share and discuss answers.

Teacher's Notes and Debriefing:

When going over the answers on Master #24b (supplied by NASA), the first 3 or 4 answers (critical to survival), and the last 3 or 4 (not essential to survival) answers would be the most important to discuss. Some of the other answers are more arbitrary and students should come to realize this.

Activity: Mini Planetarium

Materials:

cans *(with both ends removed)*
pins
flashlight
black construction paper
tape
star map

Procedure:

1. Line the inside of the can with black construction paper. Be careful of sharp edges.

2. Trace a circle (disk) on black paper that is a little larger than the top of the can.

3. Using a star map, students should "pierce" a constellation into the black disk and attach the disk to one end of the can using tape.

4. Darken the room and shine a flashlight into the can and project the constellation onto the wall.

Teacher's Notes and Debriefing:

After working with various star maps and star finders, students will enjoy making mini-planetarians. To make a mini-planetarium, use hard black Bristol board (taped into a table) or use a juice can covered in black paper and paint Look through the tube towards a light source in the room (do NOT look directly at the Sun). Change the circular disks to see other constellations.

Many students could work together and project the constellations in their correct position in the night sky. Younger students could be invited in to view this mini planetarium.

Activity: Constellation Stories

Materials:

packages of gold, silver and red stars
black manila tag
star map
Greek myths and Star Stories *(see Bibliography)*
yellow and white pencil crayons
thread
magnitude key *(see Teacher's Notes and Debriefing)*

Procedure:

1. Students will select a constellation and research the corresponding Greek myth.

2. Using the magnitude key, students will reproduce their chosen constellation on the black manila tag.

3. Students will include a brief explanation of their constellation's myth.

4. Students will place their constellations around the perimeter of the star map.

5. Students will connect their constellation to the same constellation on the star map using thread.

Teacher's Notes and Debriefing:

Teacher should remind students of the activity *Shining Student's Role Play* so that they understand that the star map they are using for this activity reflects the position of the constellations for that time of the year. The activity integrates with the *Ancient Greece* unit in Grade 6 Social Studies and can be left up for display.

Magnitude Key	
1st ma (magnitude)	very bright – *2 gold stars super imposed*
2nd ma	bright – *1 gold star*
3rd ma	fairly bright – *1 red star*
4th ma	medium – *1 silver star*
5th ma	faint – *yellow dot*

Students may be encouraged to make up an imaginary constellation and then write a myth about it.

Grade 6

Topic C

SKY SCIENCE

- APPENDIX -

- Glossary -

Altitude: The distance a heavenly body appears above the horizon as measured in degrees.

Annual Motion: The Earth's orbital motion around the Sun every year.

Aphelion: The point in the Earth's orbit where the Earth is farthest away from the Sun.

Asteroid Belt: The area between the inner and outer planets that is filled with asteroids.

Asteroids: Chunks of rock that vary in size from very large (approximately 1030 km in diameter) to quite small. They orbit the sun between the orbits of Mars and Jupiter. About 3000 asteroids have been discovered.

Asterism: Stars that form patterns but are generally smaller than or part of a constellation. The Big Dipper is an asterism and forms part of the constellation Ursa Major.

Astronomy: The study of the Universe and all of the bodies that appear in the skies.

Atmosphere: A layer of air between the Earth and outer space.

Axis: A straight line that an object or body rotates, or seems to rotate around.

Binary Stars: When two relatively close stars revolve around each other, often appearing as single stars because they are so far away from the Earth.

Black Hole: An intense gravitational field created when a star runs out of fuel and collapses. Nothing, not even light can escape its pull.

Blue Moon: The second full moon in the same calendar month.

Calibrate: To determine, check or adjust a scale of any measuring instrument.

Celestial Equator: An imaginary line in the sky directly above the Earth's equator.

Celestial Hemisphere: The heavens surrounding the Earth, split into two parts directly above the Earth's equator, can be identified as the northern and southern celestial hemispheres.

Celestial Sphere:	The heavens surrounding the Earth.
Comet:	A large ball of ice, dust, rock and gas that orbits the Sun, circling the dark edges of the Solar System.
Constellations:	Bright stars grouped according to the patterns they make in the sky (such as Orion or Ursa major). There are 88 constellations that cover the sky; many of their names coming from characters in ancient mythology.
Copernicus, Nicolaus (1493-1543):	A Polish scientist who was the first to re-introduce the idea originally stated by some radical Greek philosophers 2000 years earlier, that the Sun and not the Earth, was the center of the solar system.
Crater:	A hole created on the surface of an object or body, made by falling meteorites or by erupting volcanoes.
Emit:	To send or give out.
Eclipse:	Of two types, solar and lunar. A solar eclipse is when the moon passes in front of the Sun, covering the Sun's disk, either partially or totally. A lunar eclipse is when the full moon passes through the Earth's shadow, and sunlight is prevented from falling onto the moon's surface. From Earth, The moon appears to grow dark.
Ecliptic:	The apparent great–circle annual path of the Sun, as seen from the Earth. It is called the *ecliptic* because eclipses occur only when the moon is on or near this path.
Equator:	An imaginary circle around the centre of the Earth, perpendicular to the axis of rotation.
Equinox:	During the Sun's annual path in the sky it crosses the celestial equator at two points – the equinox points. On these two days on or about March 21, September 23, of every year, the day is divided between twelve hours of sunlight and twelve hours of darkness.
Galaxy:	A spiral island of stars in space. Our galaxy is called the Milky Way.
Gibbous:	A phase in the Moon's cycle when more than half of the moon, but not the entire face of the Moon, is illuminated.

Gravity: A force that attracts and holds the universe together. It gives objects weight.

Hemispheres: Either the north or the south half of the Earth divided by the equator, or the east or west half divided by the prime meridian.

Inner Planets: The four hard rocky planets – Mercury, Venus, Earth, Mars – closest to the Sun.

Latitude: The distance of a point on the Earth's surface north or south of the equator, measured in degrees. For example, Edmonton's latitude is 53.5° North. The latitude of the Canada – USA border in western Canada is 49° North.

Light Year: The distance light travels in a year. This unit is used to measure distances in space. One light year is about 9.5 trillion km.

Longitude: This distance of a point on the Earth's surface measured parallel to the equator west from the 0° Greenwich Meridian. Edmonton's longitude is 113.4° west.

Lunar Eclipse: When the moon moves into the Earth's shadow, preventing sunlight from falling onto the moon's surface.

Lunar Month: The time it takes the moon (27 1/3 days) to go around the Earth.

Lustre: Sheen or shine.

Magnitude: A scale used to measure the brightness of stars and other objects in the sky. Magnitudes range from: -23 (the Sun) -3 to -4.5 (Venus) to stars from -1.5 → 21 or fainter.

Meteor: When a meteoroid enters the Earth's atmosphere, creating a bright streak of light, it is called a meteor or a shooting star.

Meteorite: Larger meteors that fall to the surface of the Earth.

Meteoroids: These rocks, usually not much bigger than grains of sand, may have been swept off asteroids and comets. They also orbit the Sun, sometimes entering the Earth's atmosphere.

Midnight Sun: On June 21st from a point on the *Arctic Circle*, the Sun will appear to descend into the north-west, but instead of setting it will appear to skim the northern horizon and rise up again in the north-east. This never–setting sun known as the M*idnight Sun*. The further north you go the more days of Midnight Sun you experience during the year.

Moon: The name of the satellite that orbits the Earth.

Moon Phases: A cycle in which the Moon appears in different forms as it orbits the Earth.

Orbit: The path of a planet or other heavenly body as it revolves around another body in space.

Outer Planets: The four giant, gaseous planets – Jupiter, Saturn, Uranus, Neptune – and Pluto that orbit the Sun.

Perhilion: The point in the Earth's orbit where it is closest to the Sun.

Planets: Large bodies that can only be seen by reflected light, as they revolve around the sun. The word planet comes from the Greek word wanderer.

Pole Star: A bright star, also known as North Star or Polaris, that appears in the sky in the northern hemisphere. A useful bench mark as it always stays in the same position in the northern sky.

Revolution: The motion of a planet along its orbit around the Sun. For example, the Earth takes one year to "revolve" around the Sun.

Rotation: The motion of a planet satellite, or the Sun around its north-south axis. It takes 24 hours for the Earth to rotate once on its axis.

Satellite: A man made or heavenly body (Moon) that orbits around a larger object.

Solar Eclipse: When the Moon passes in front of the Sun, partially or totally covering it.

Solar Noon: When the Sun reaches its highest point in the sky.

Solar System: The Sun and all of the bodies – planets, satellites, asteroids, comets, etc. that orbit around it.

Solstices: Once a year the Sun reaches it highest and lowest points in the sky at noon. In the northern hemisphere, the lowest point and least number of daylight hours takes place on or about December 21st. It reaches its highest point and greatest number of daylight hours on or about June 21st. In the Southern Hemisphere the dates are reversed.

Star: A gaseous body that produces its own energy through nuclear fusion, releasing it as light and heat.

Stellar Astronomy: The study of the stars.

Sublimate: To turn directly from a solid into a gas.

Sun: The closest star to the Earth, measuring more than a million kilometers across.

Sundial: A device that uses shadow to tell time.

Texture: The surface look or feel of something.

Universe: Everything that exists: the Earth, the Sun, the Moon, satellites, stars, asteroids, all the galaxies and the space in between them.

Waning Moon: When the Moon grows gradually more illuminated when passing from new to full moon.

Waxing Moon: When the Moon grows gradually more illuminated when passing from new to full moon.

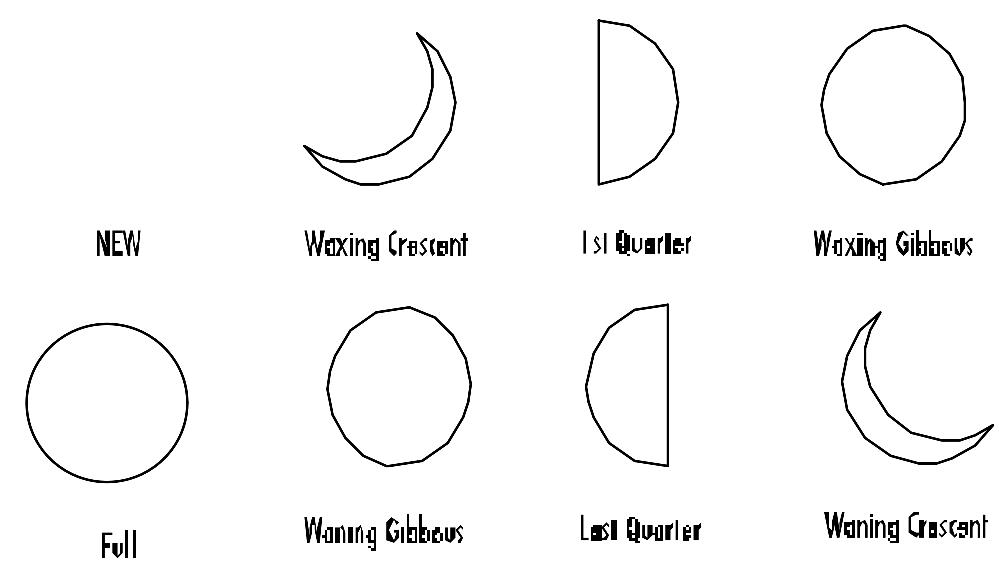
Year: The time it takes for a planet to go all the way around the Sun i.e., on Earth a year is 365 days. One year on Uranus is 84 earth years.

Name: ____ *Master #1*

Date: ____

Moon Recording Sheet

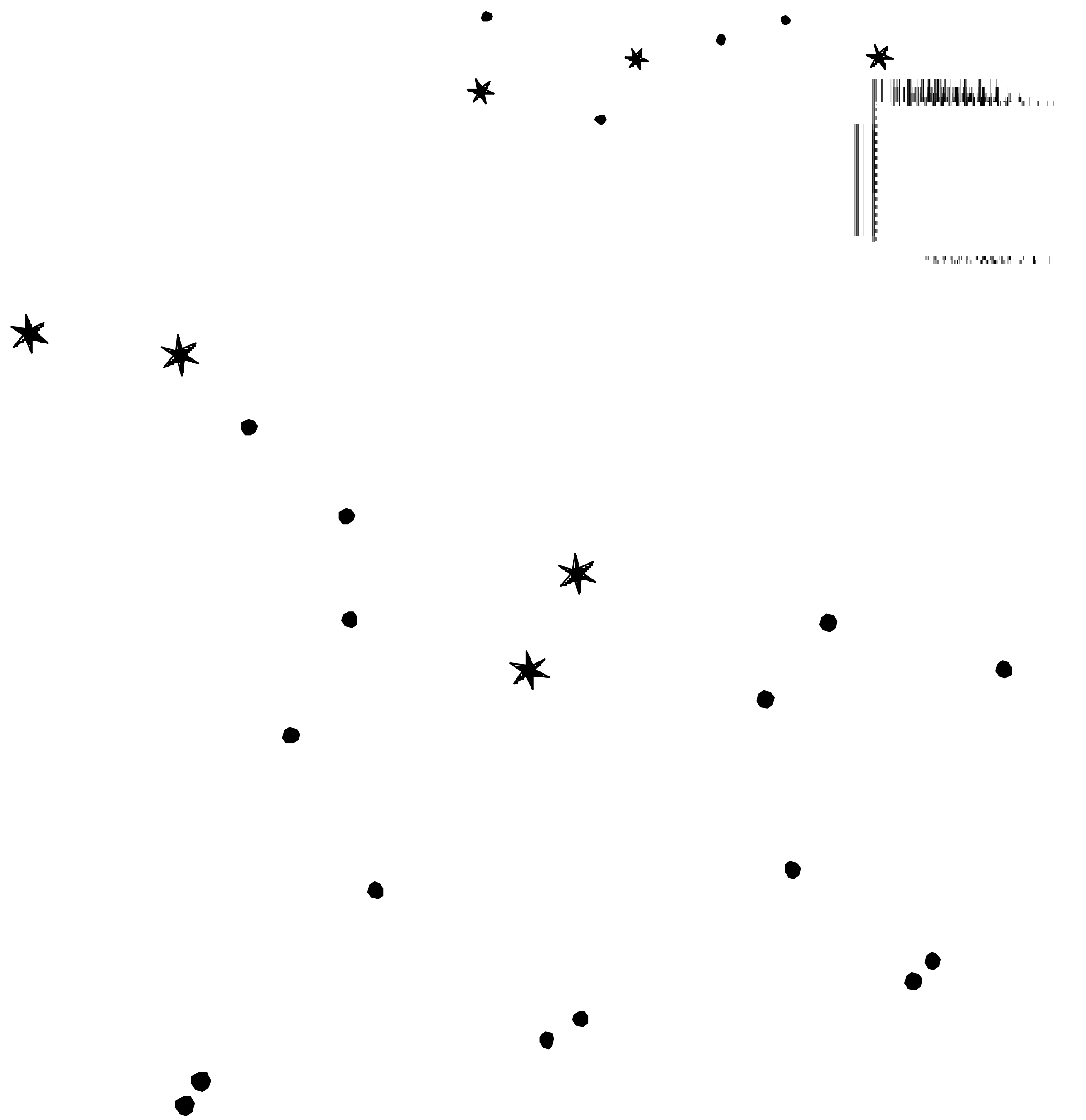
Phases of the moon:



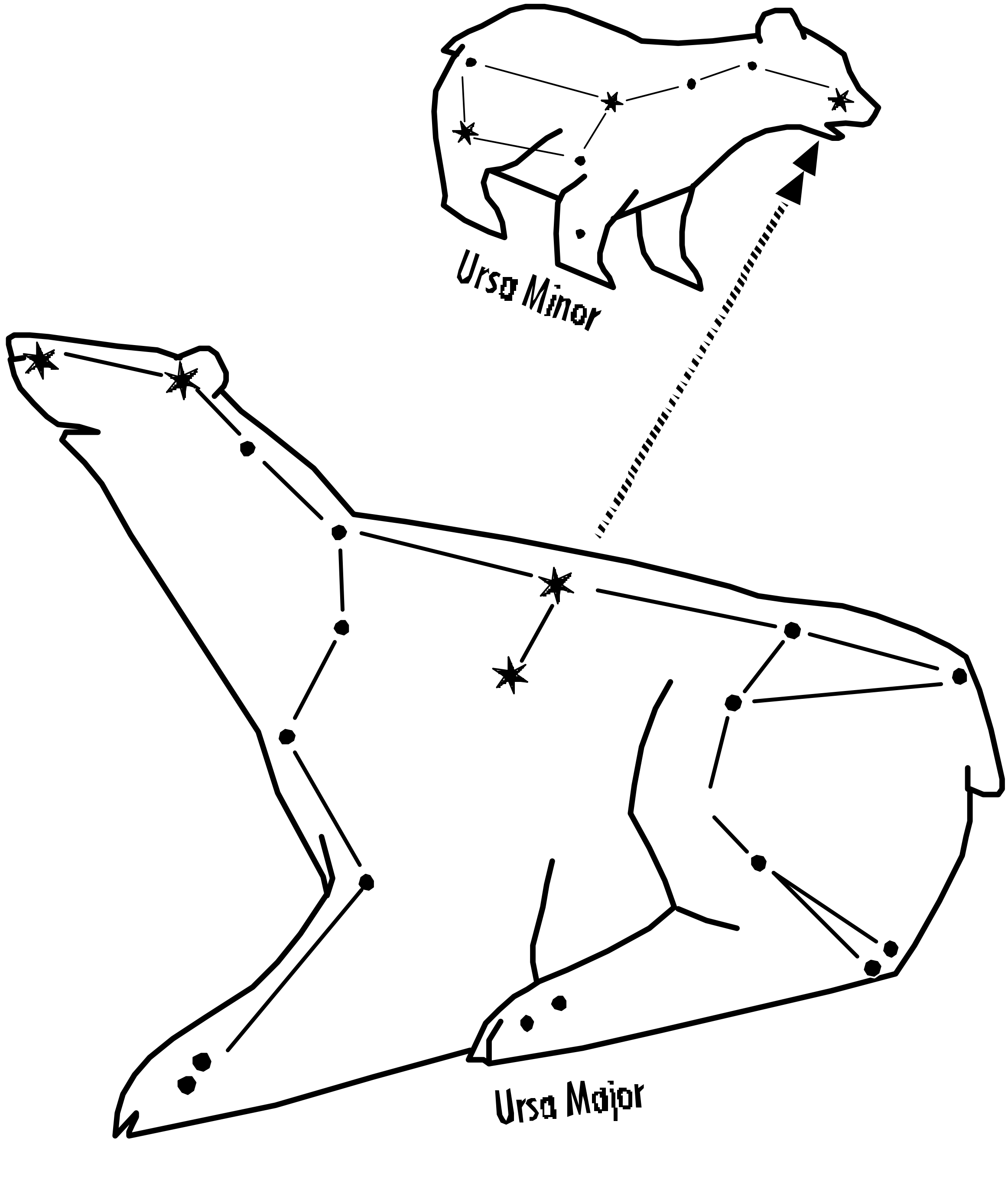
Date and Time Observation	Phase of Moon	Date and Time Observation	Phase of Moon

Name: ____ *Master #2a*

Starry Starry Night – Student Sheet



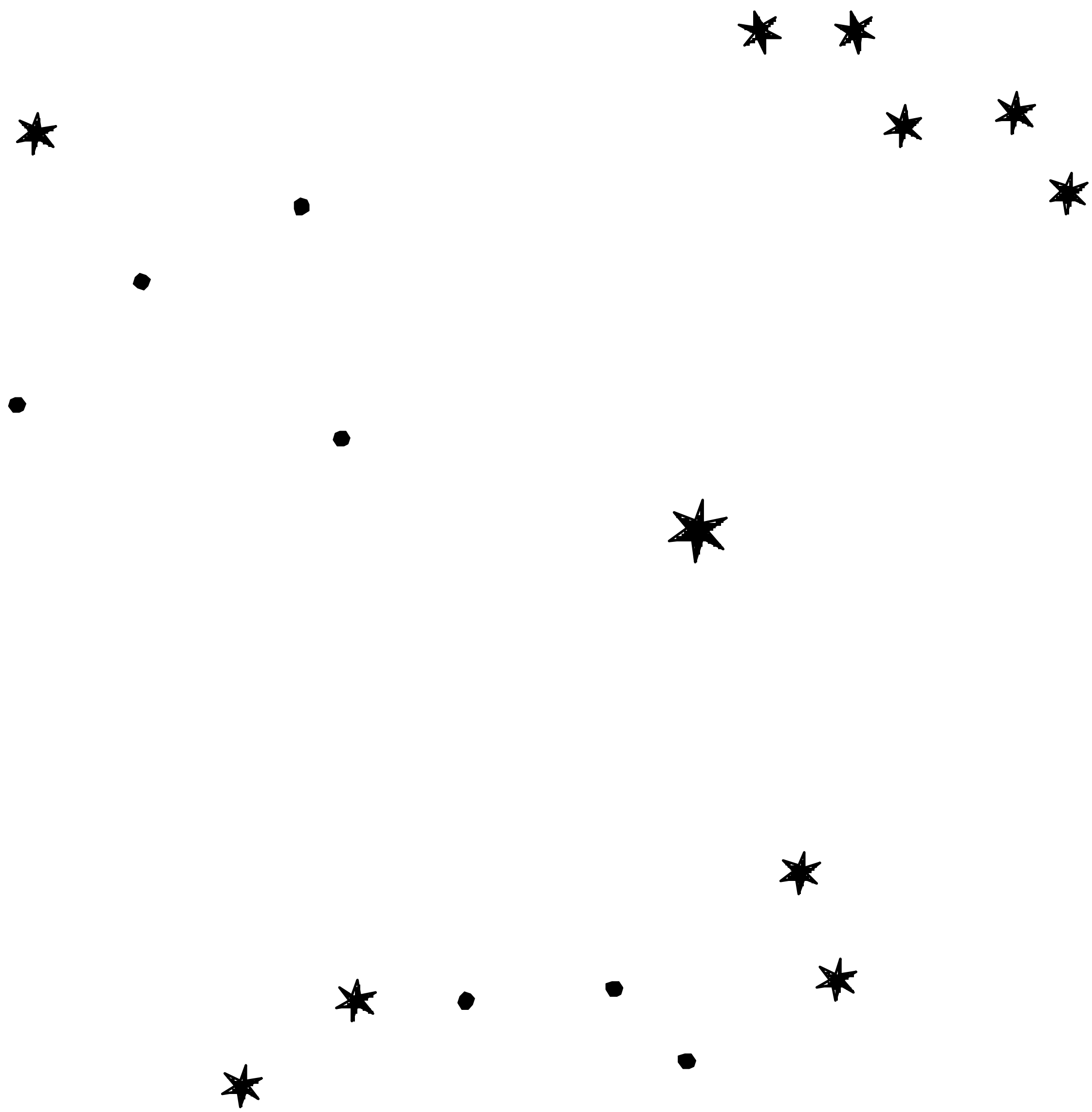
Starry Starry Night – Teacher Key



Name: ____ *Master #2c*

Date: ____

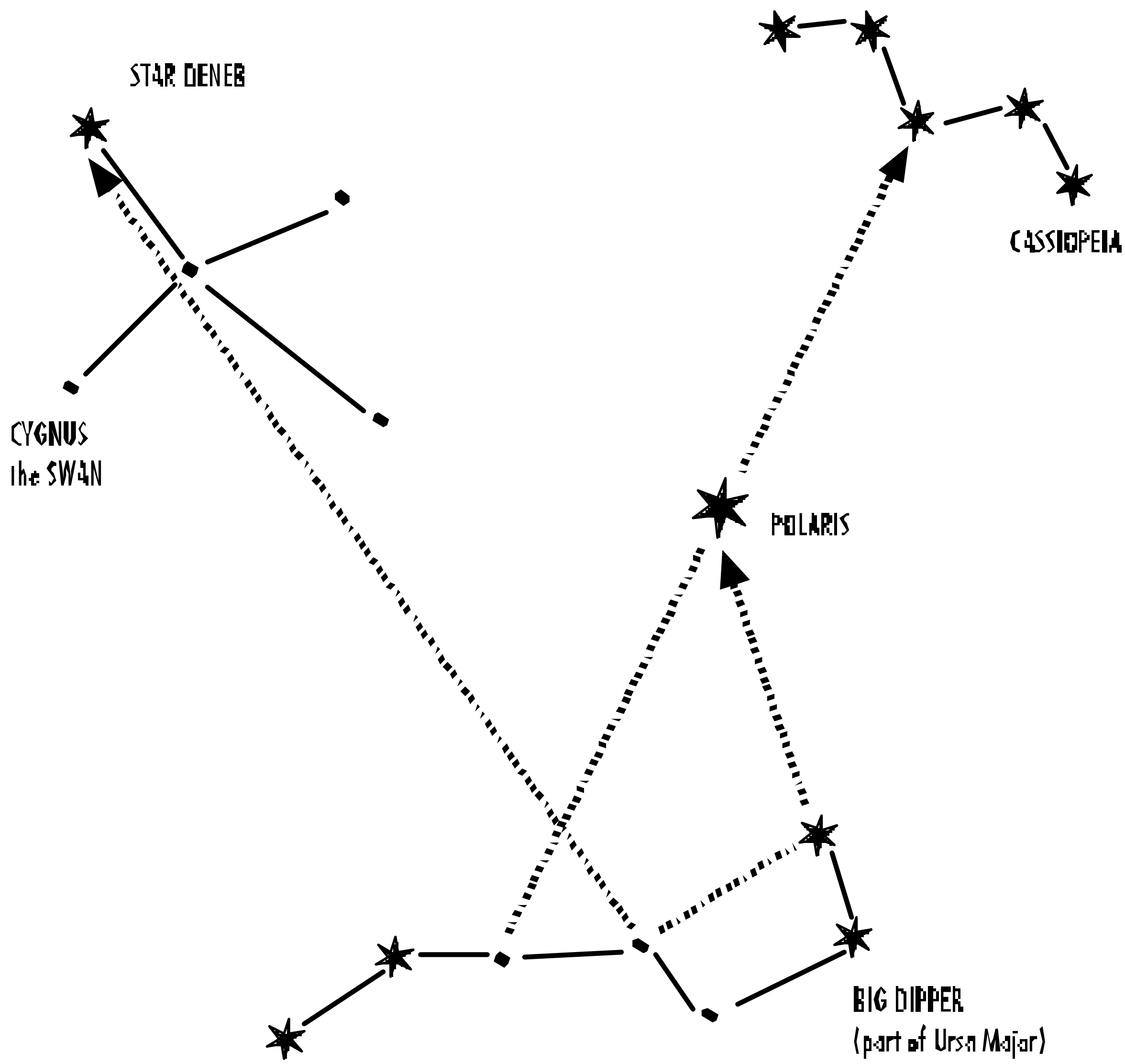
Constellations – Student Sheet



Name: ____ *Master #2d*

Date: ____

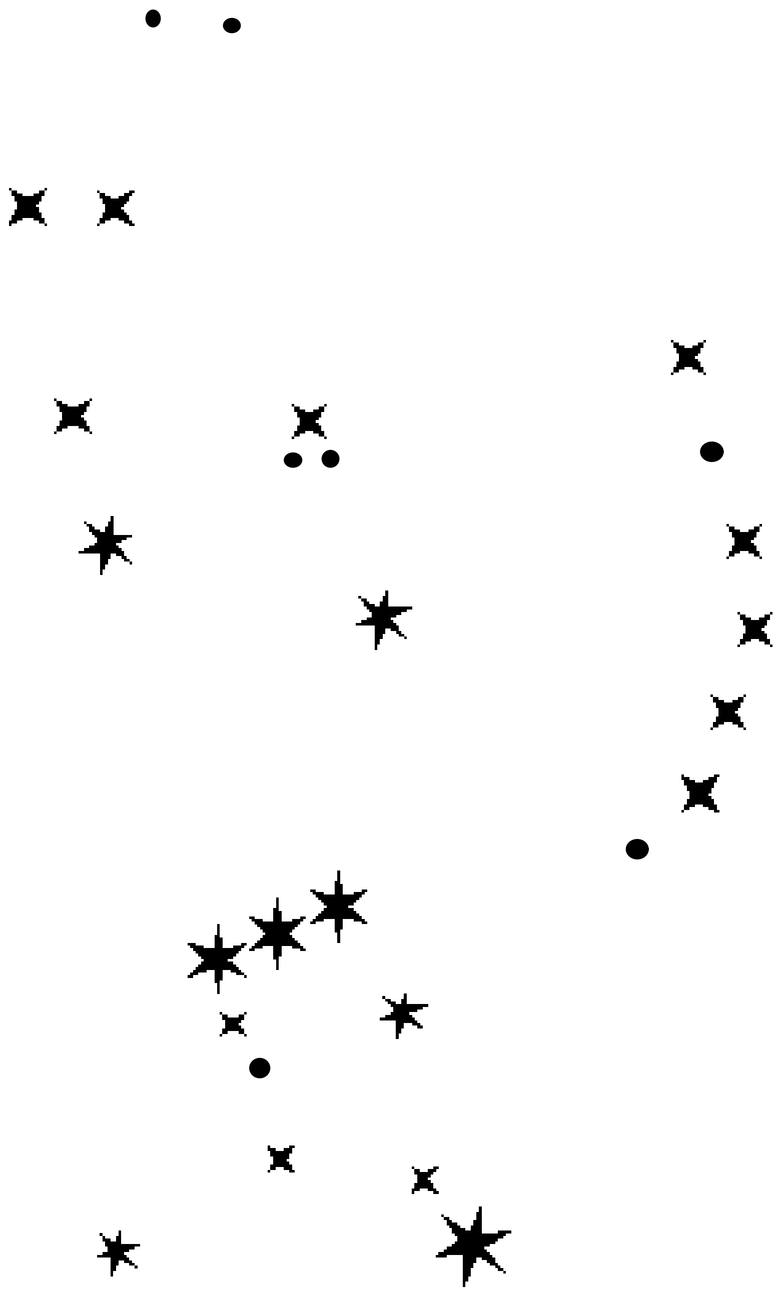
Constellations – Teacher Key



Name: ____ *Master #2e*

Date: ____

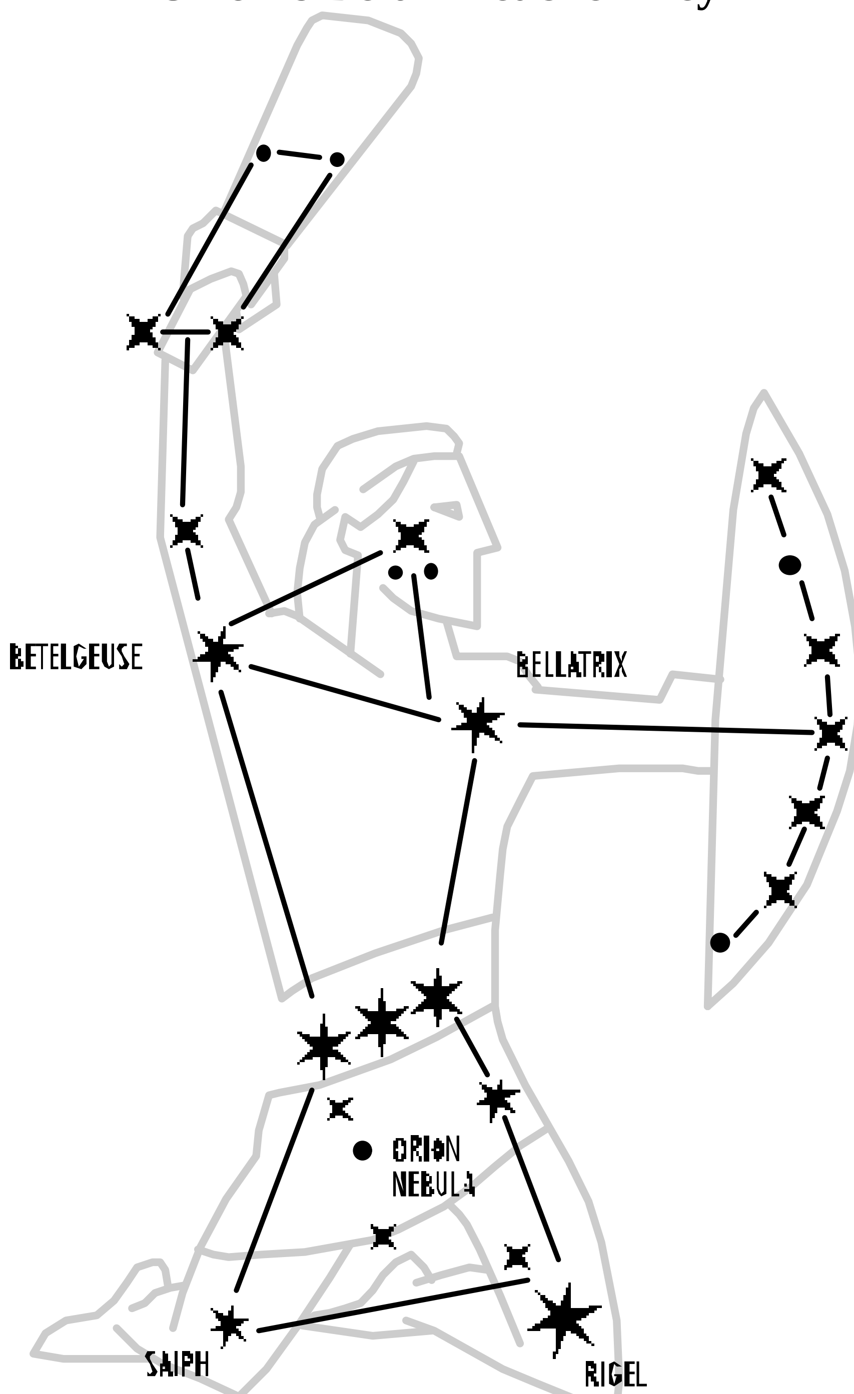
Orion's Belt – Student Sheet



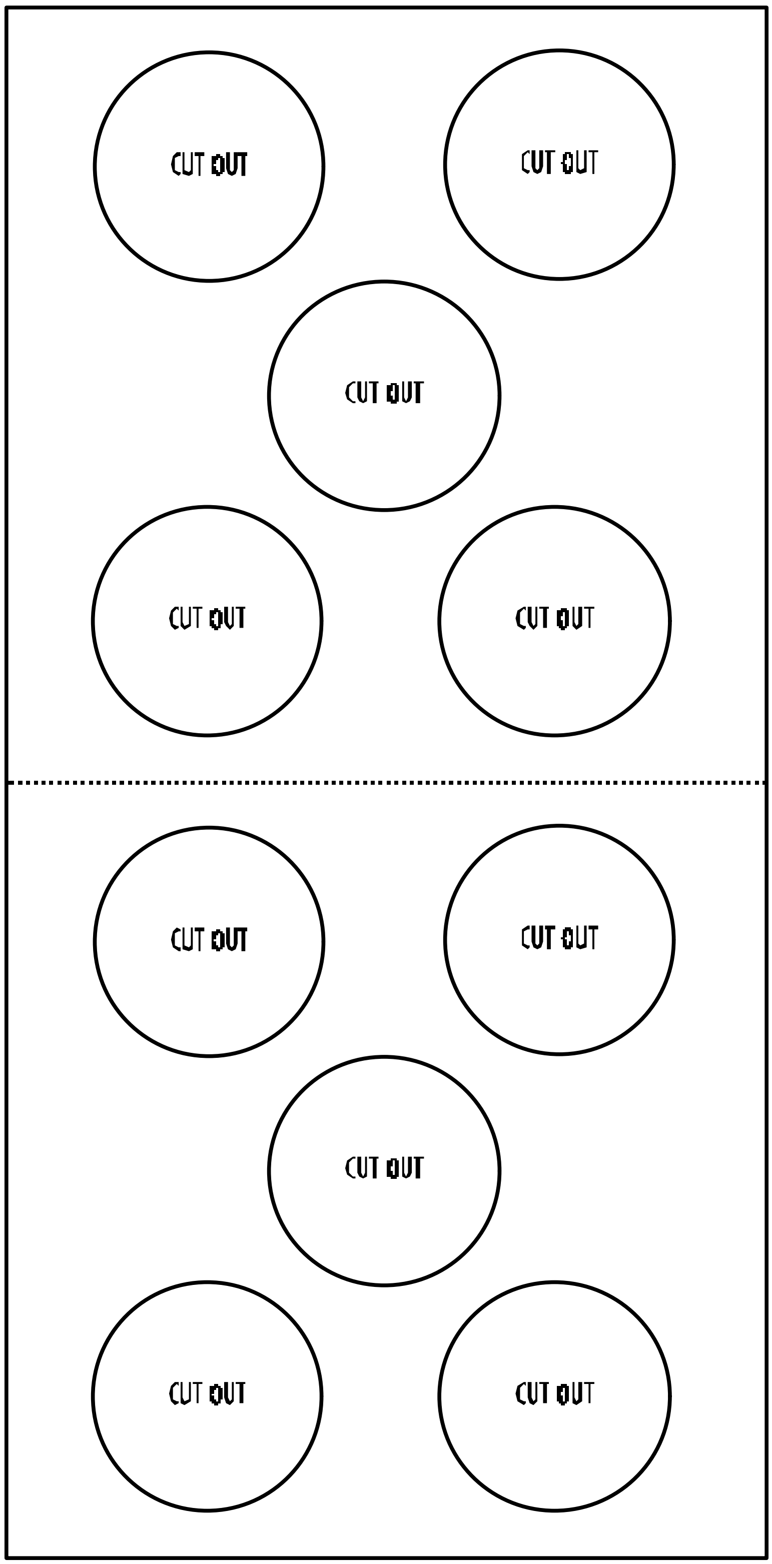
Name: ____ *Master #2f*

Date: ____

Orion's Belt – Teacher Key



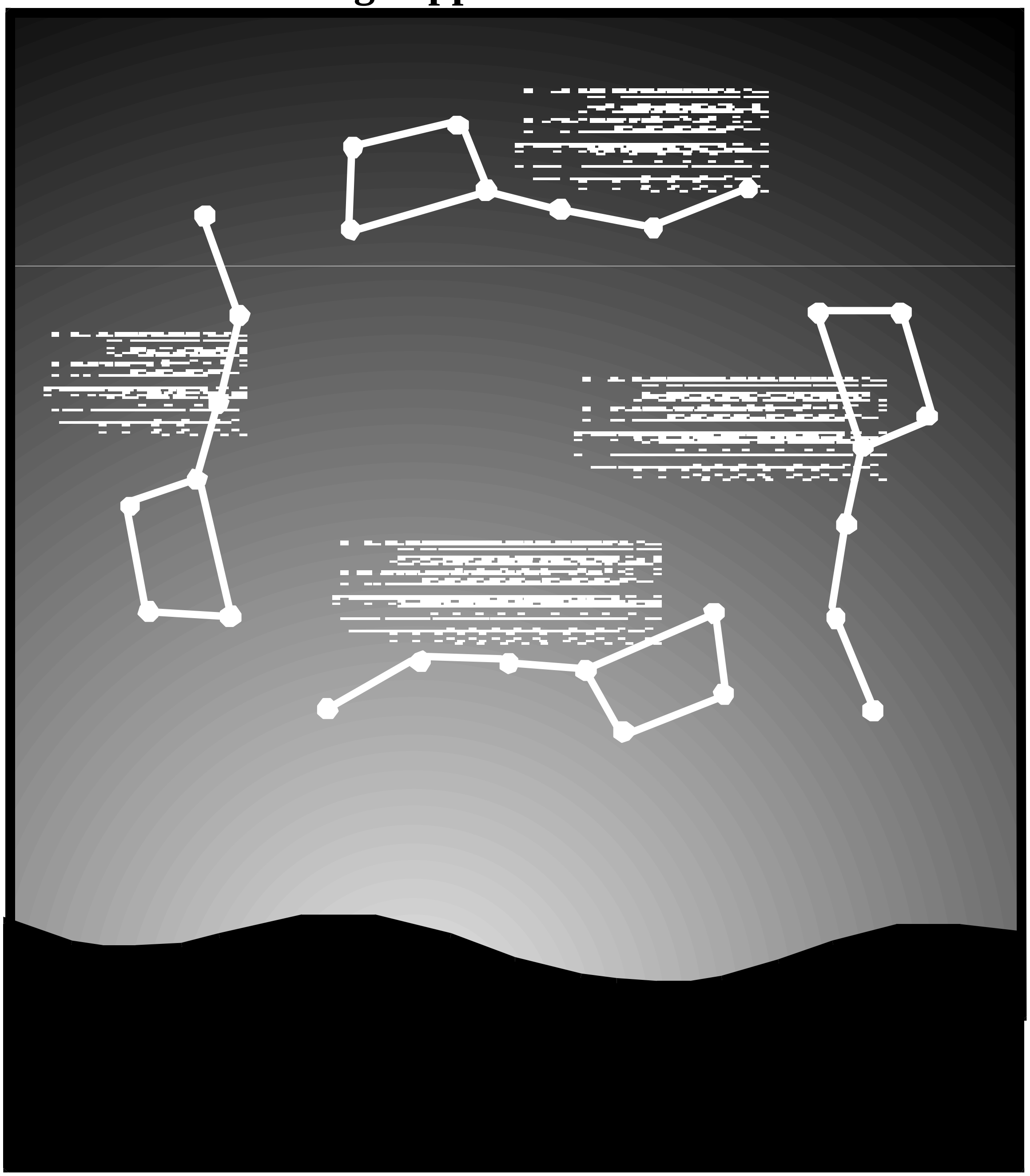
Brightness Gauge



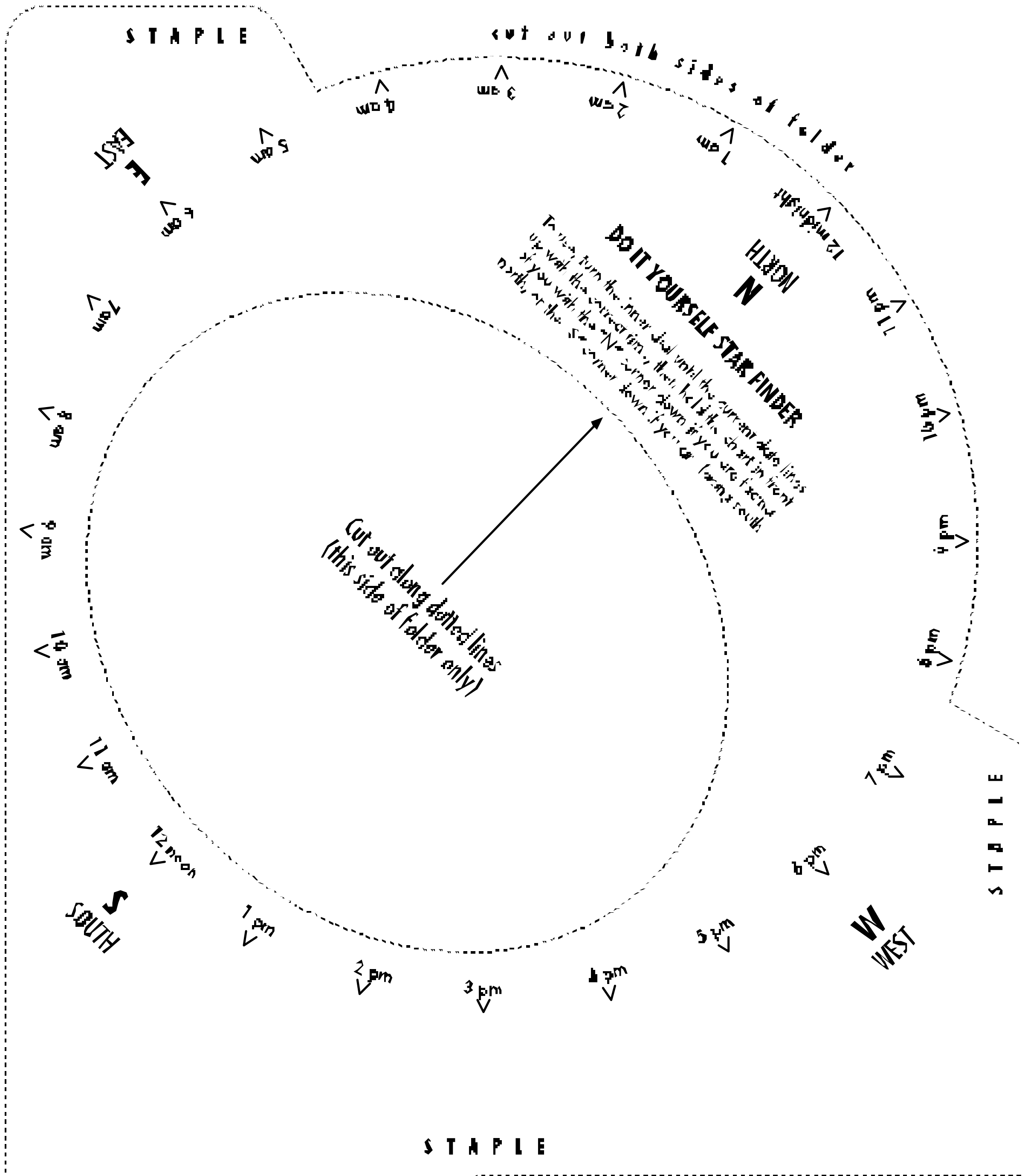
Name: ____ *Master #4*

Date: ____

Big Dipper Movement

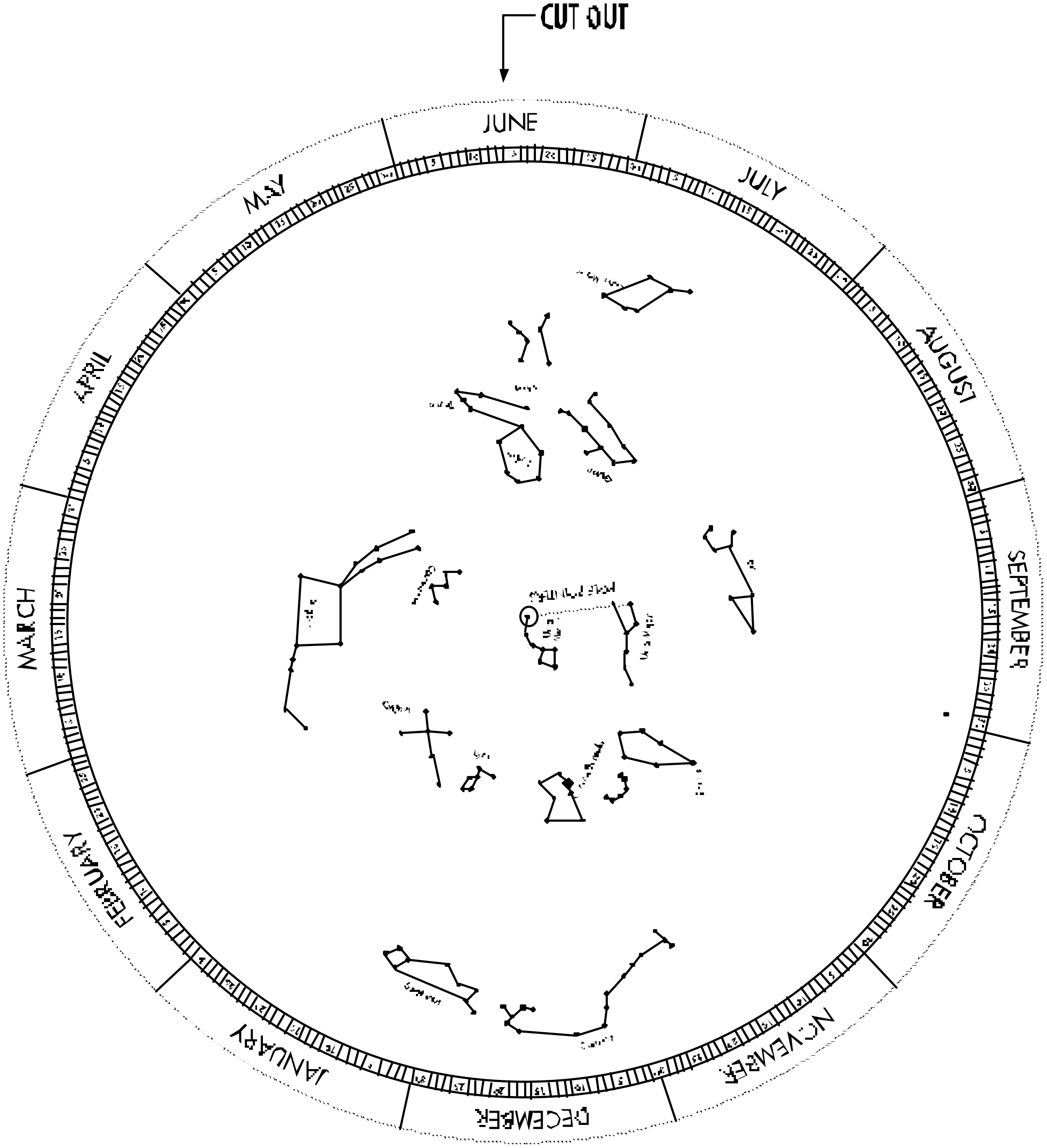


Star Finder

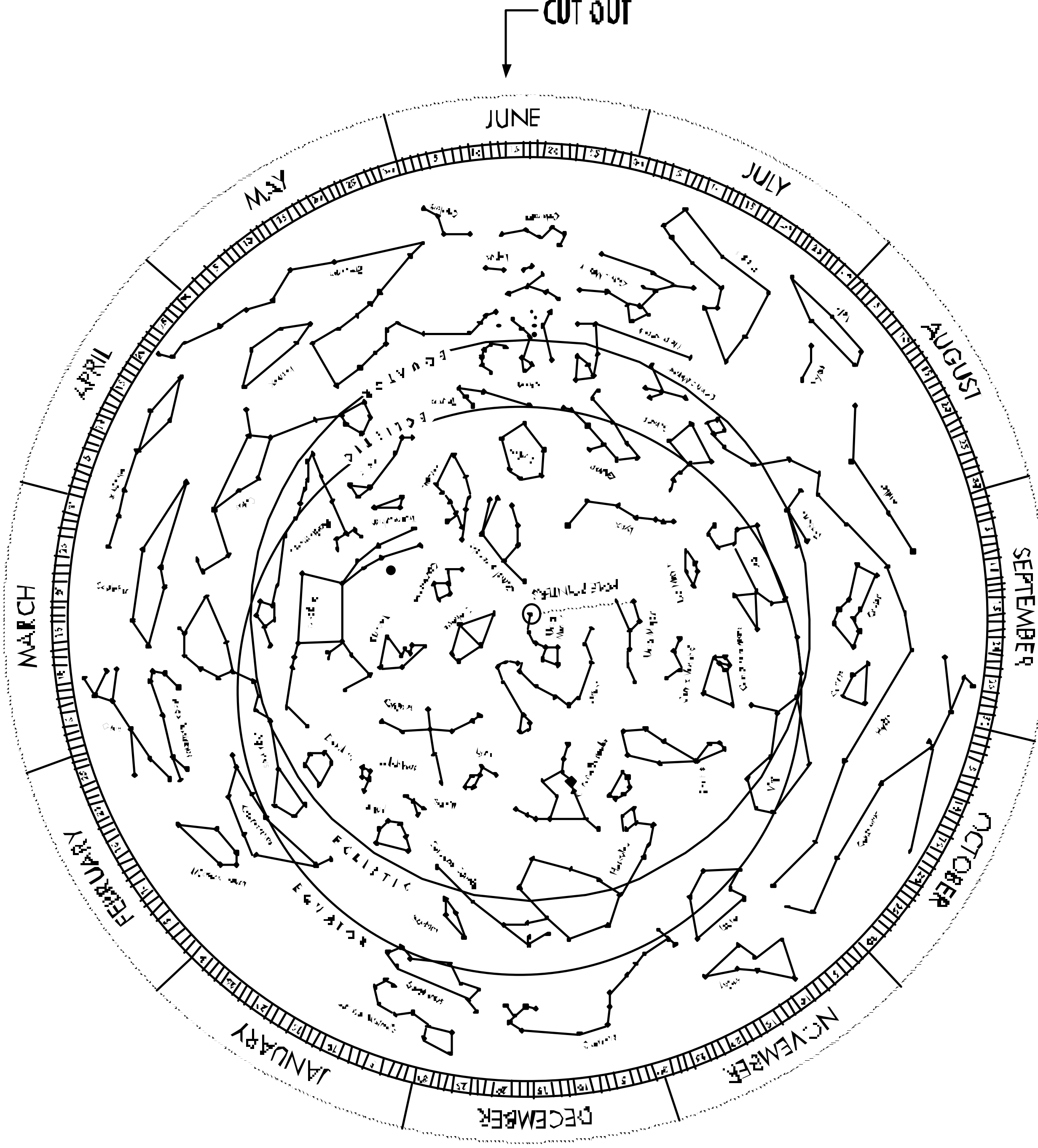

STAPLE
cut out both sides of folder
DO IT YOURSELF STAR FINDER
N
NORTH
E
EAST
S
SOUTH
W
WEST
Cut out along dotted lines
(this side of folder only)
12 midnight
1 am
2 am
3 am
4 am
5 am
6 am
7 am
8 am
9 am
10 am
11 am
12 noon
1 pm
2 pm
3 pm
4 pm
5 pm
6 pm
7 pm
8 pm
9 pm
10 pm
11 pm
STAPLE
STAPLE

Star Finder – Simplified Version

1. Cut out Masters #6 and #7
2. Glue #6 and #7 <u>back to back</u> – It is not necessary to match the months on Masters #6 and #7.



Star Finder – Complex Version



Name: ____ *Master #8*

Date: ____

Star Finder – Recording Sheet

Look at the night sky once a week for five weeks. Make a journal of your observations in the table below. Use the instruments we made in class *(Star Finder Brightness Gage)*.

Date	**Constellations visible** *(List 3)*	**Brightness investigation** *(Name of the constellation)*

Name: ____ *Master #9a*

Date: ____

Casting Shadows – Recording Sheet

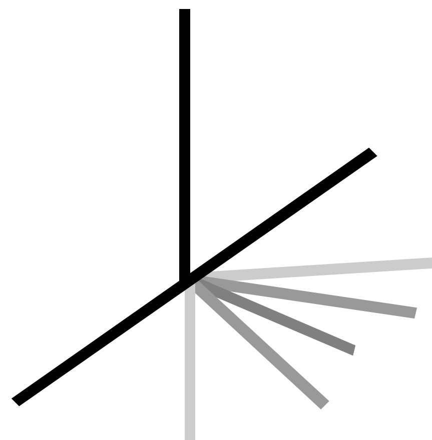
SHADOWS	
Time	**Length of Shadow**

Name: ____ *Master #9b*

Date: ____

Casting Shadows

SHADOWS	
9:00	191 mm
9:30	186 mm
10:00	177 mm
10:30	168 mm
11:00	150 mm
11:30	147 mm
12:00	149 mm
12:30	145 mm
1:00	159 mm
1:30	163 mm
2:00	179 mm
2:30	182 mm



Measuring the length of shadows cast by a stick at various points throughout the day, provides you with data that can easily be turned into a bar graph. Use the data in the table above to complete this graph.

Shadow length ***(mm)***

9:00	**9:30**	**10:00**	**10:30**	**11:00**	**11:30**	**12:00**	**12:30**	**1:00**	**1:30**	**2:00**

Time

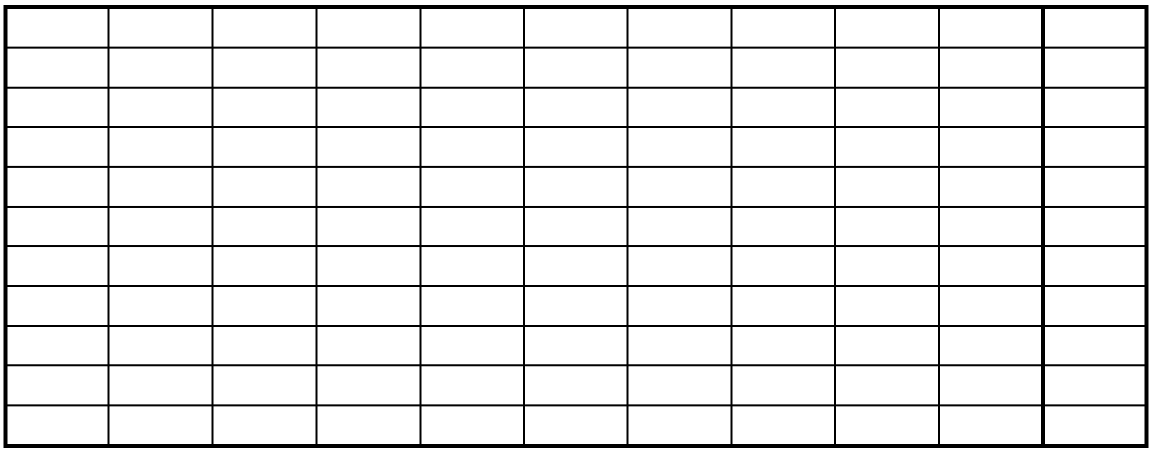
Name: ____ *Master #10*

Date: ____

Shadow Graph

<u>Shadows</u>

Shadow length *(mm)*



Time

1. Describe the *pattern/trend* formed by your graph.

____

____

____

____

2. How did the *length* of the shadow change throughout the day?

____

____

____

____

3. At what time did the *shortest* shadow occur?

____

____

4. Determine the approximate time of *"solar noon"* by comparing your results with your classmates.

____

____

____

____

5. Do you think that *"solar noon"* will be the same time tomorrow? Explain.

____

____

____

____

6. Would the shadows make the same pattern/trend if this data was collected in another *season*? Explain.

____

____

____

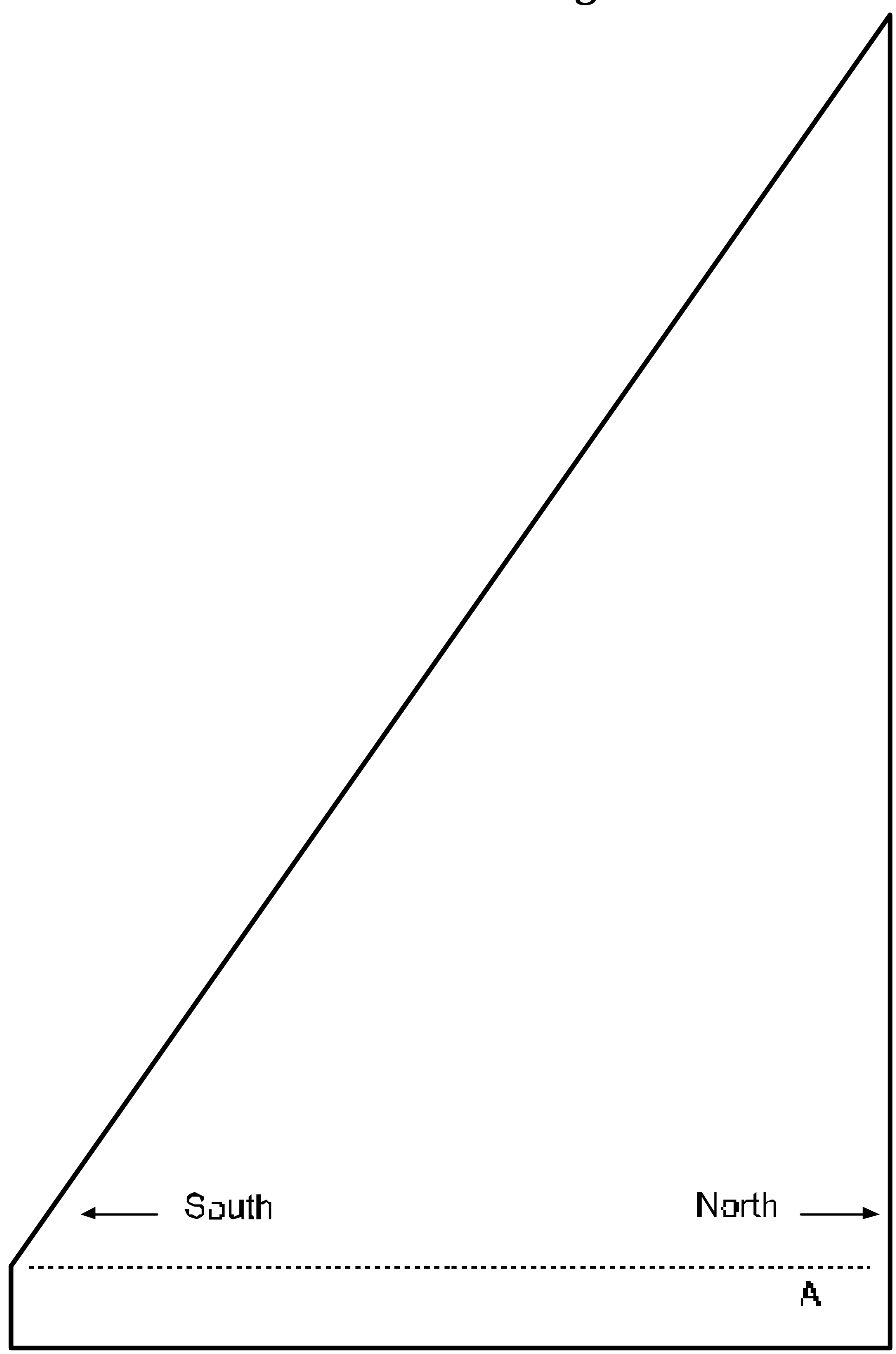
____

7. Labeled diagram:

Name: ____ *Master #11a*

Date: ____

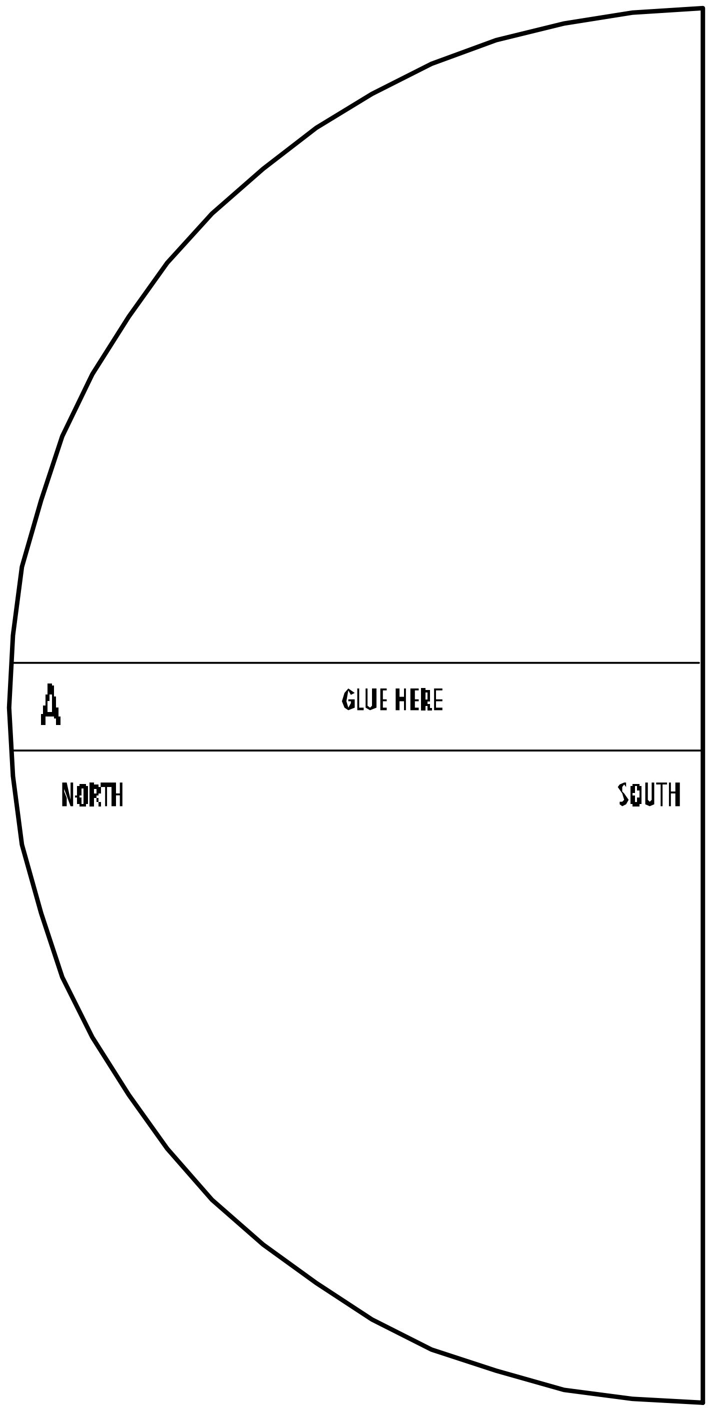
Sundial – Triangle



Name: ____ *Master #11b*

Date: ____

Sun Dial – Base



Name: ____ *Master #11c*

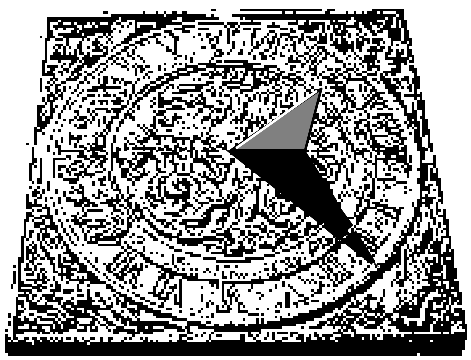
Date: ____

Sundials

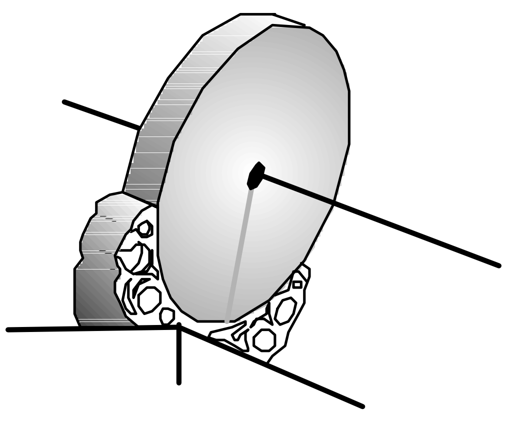
A sundial an instrument that uses shadows to tell time.

The Sun's apparent movement across the sky acted as the principal timekeeper for early people, and predominated as the main means for telling time. The sundial consists of a triangular central piece *(gnomon)* which casts a shadow on a numbered scale of hours.

*****The numbers are placed *closer* together towards noon, and *farther* apart towards morning and evening, because the shadow moves more slowly over the sundial at midday when the sun is overhead.



Ancient Sundial:

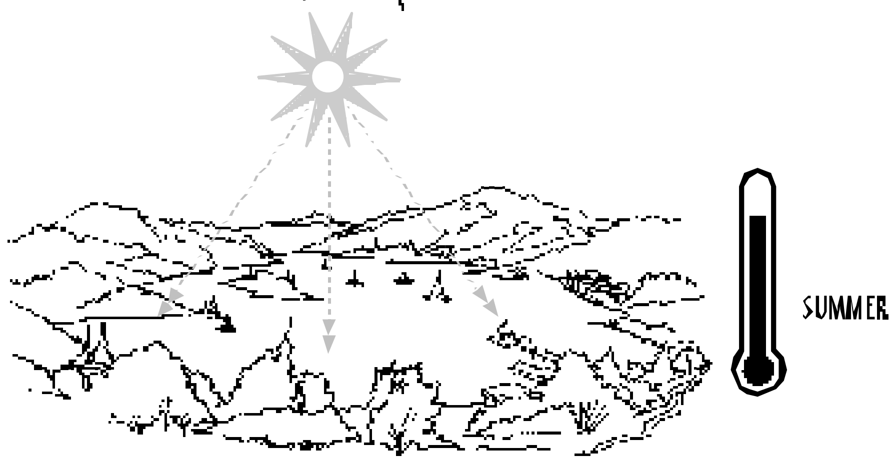


Sundial from China

Name: ____ *Master #12a*

Date: ____

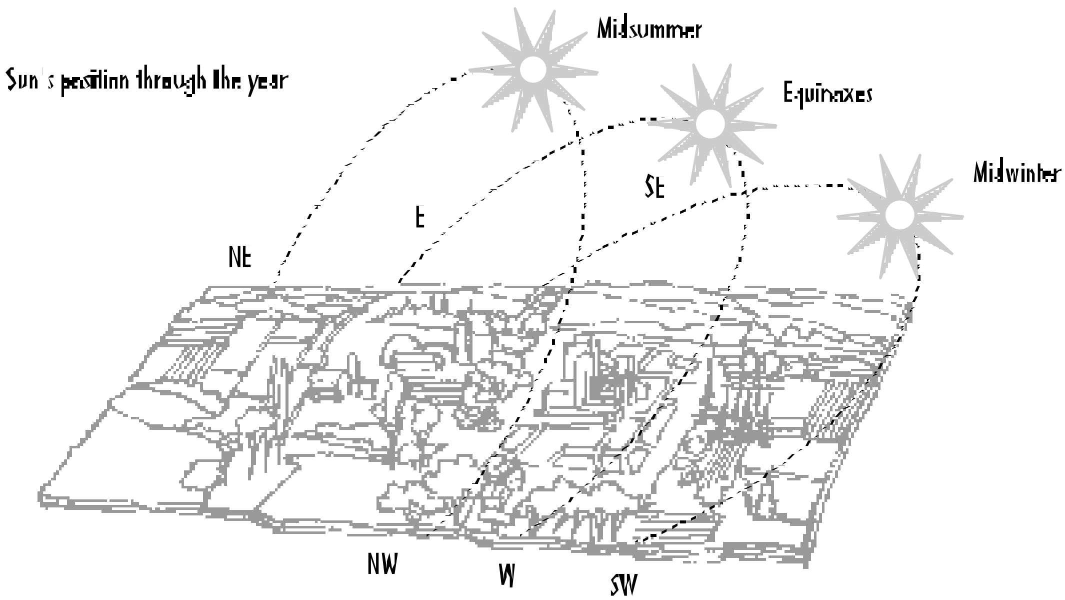
Reasons For The Seasons – Pictures

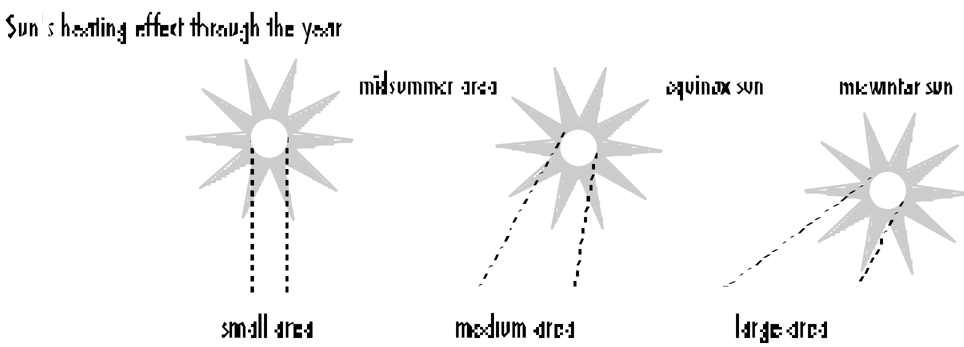


Name: ____

Date: ____

Reasons For The Seasons – Sun's Position and Heating Effect

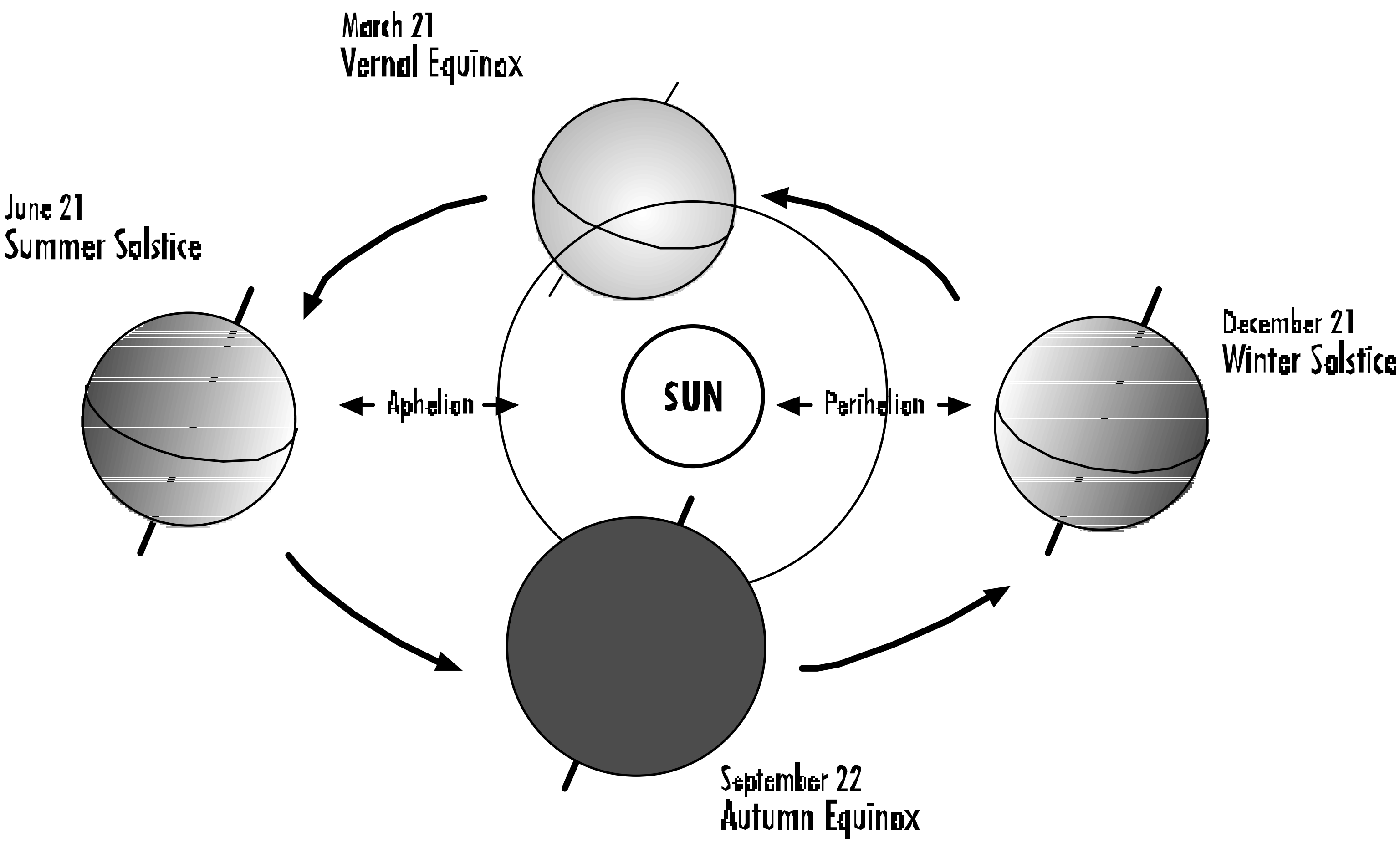




Name: ______________________________ *Master #12c*

Date: ______________________________

Reasons For The Seasons – Diagram



Name: ____ *Master #13*

Date: ____

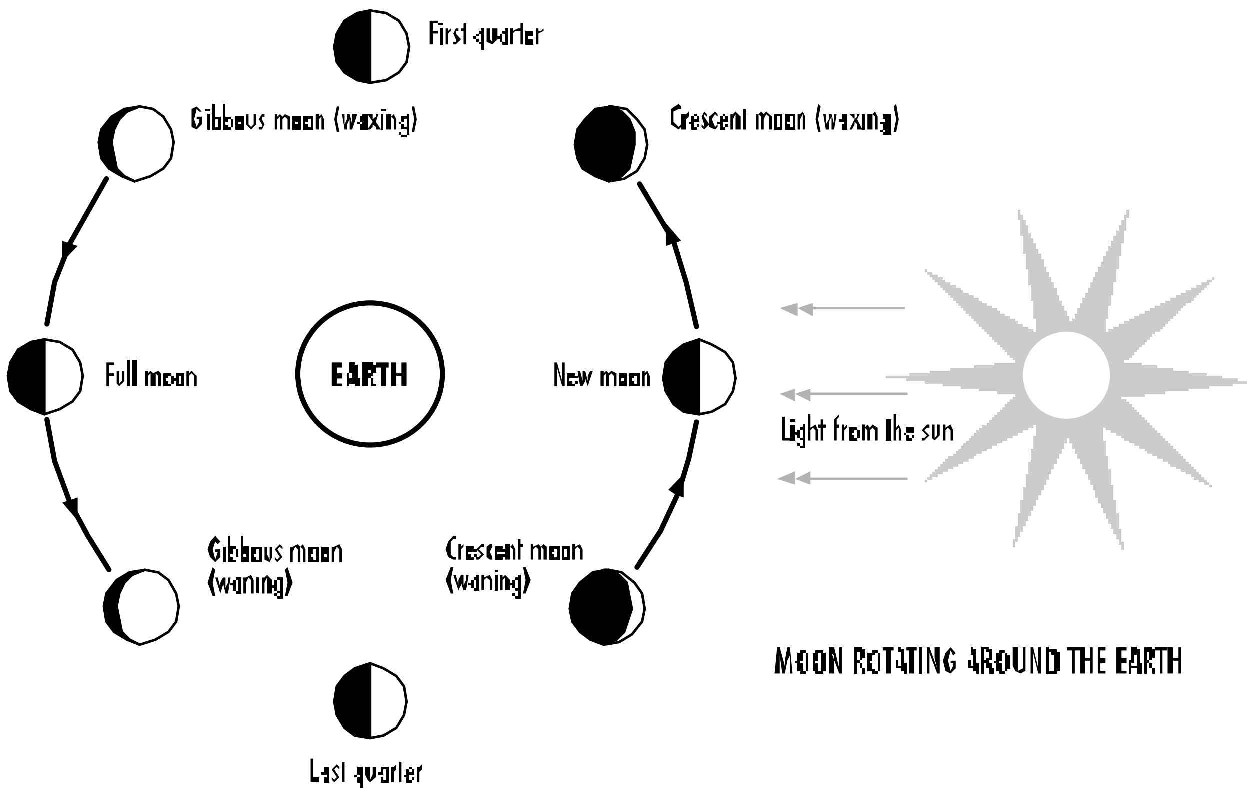
Introducing the Moon – KWL Chart

What I *Know*	**What I *Want* to know**	**What I *Learned***

Name: ______________________________________ *Master #14*

Date: ______________________________________

Introducing the Moon

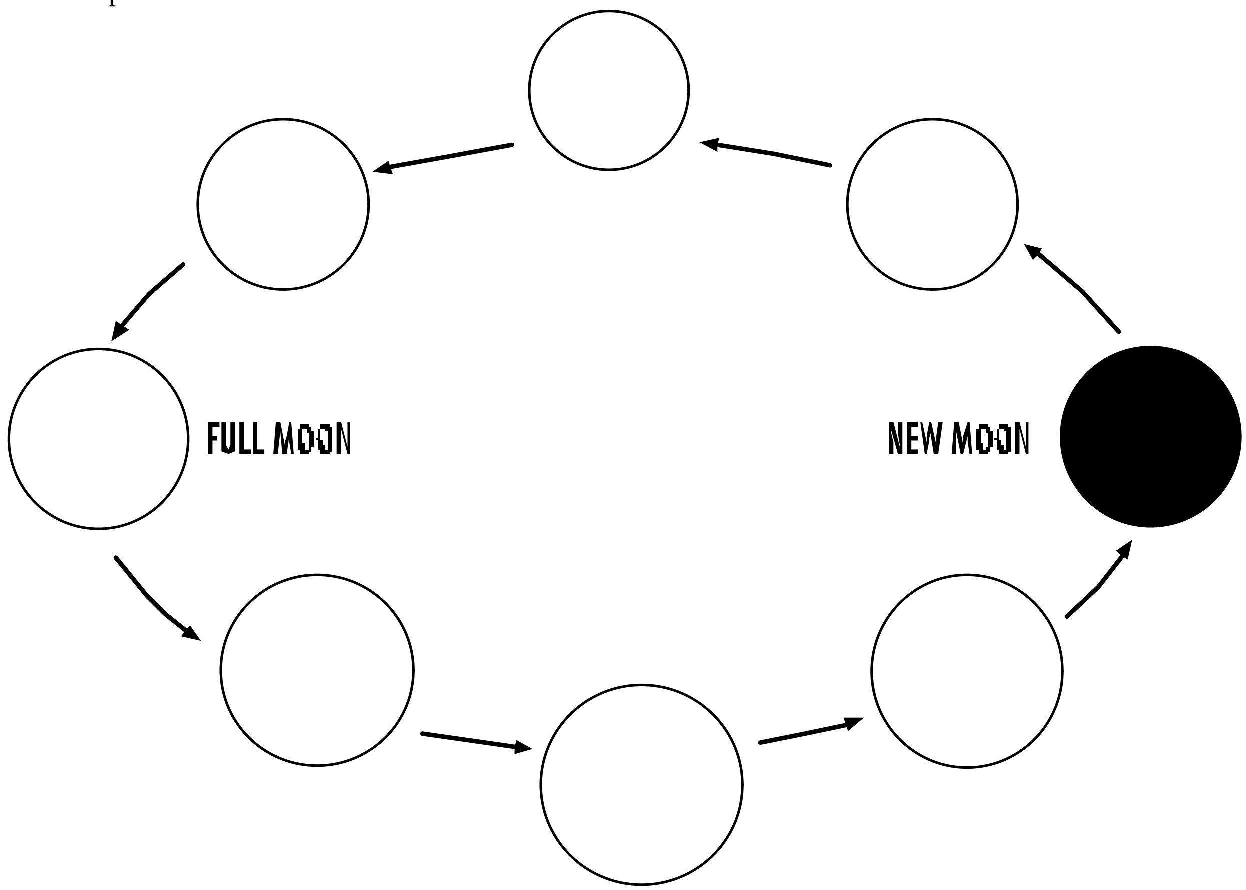


Name: ____ *Master #15*

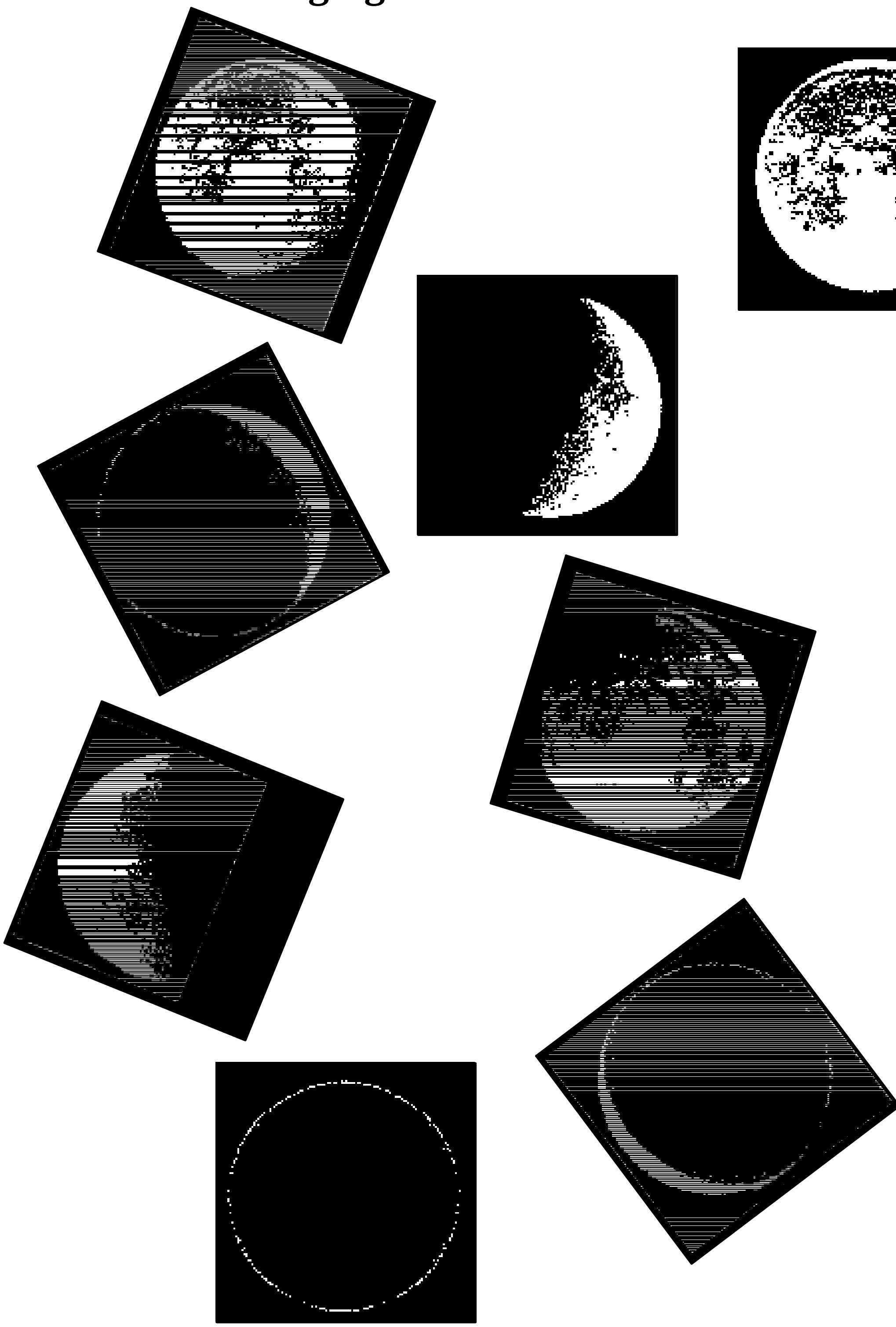
Date: ____

The Phases of The Moon

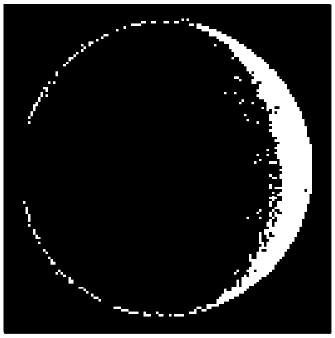
Draw, colour and label the phases of the Moon.

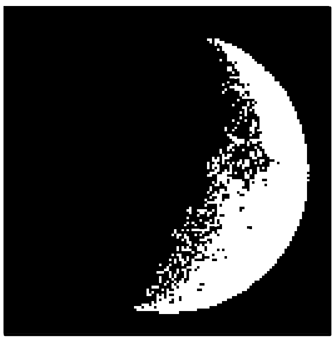


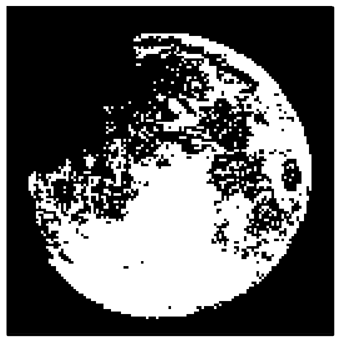
Changing Moon – Student Sheet

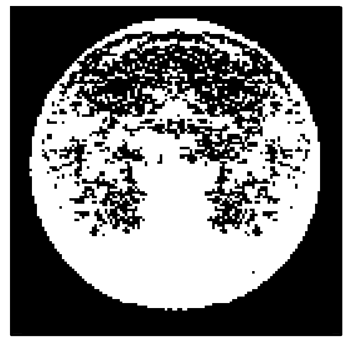


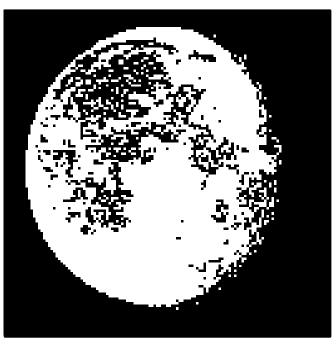
Changing Moon – Teacher Key


WAXING CRESCENT

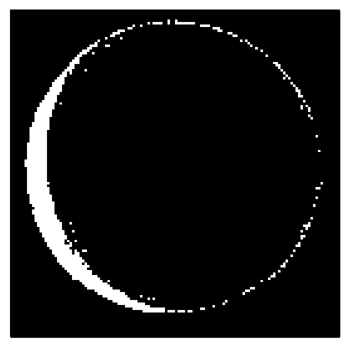

1ST QUARTER


WAXING GIBBOUS


FULL MOON


WANING GIBBOUS


LAST QUARTER

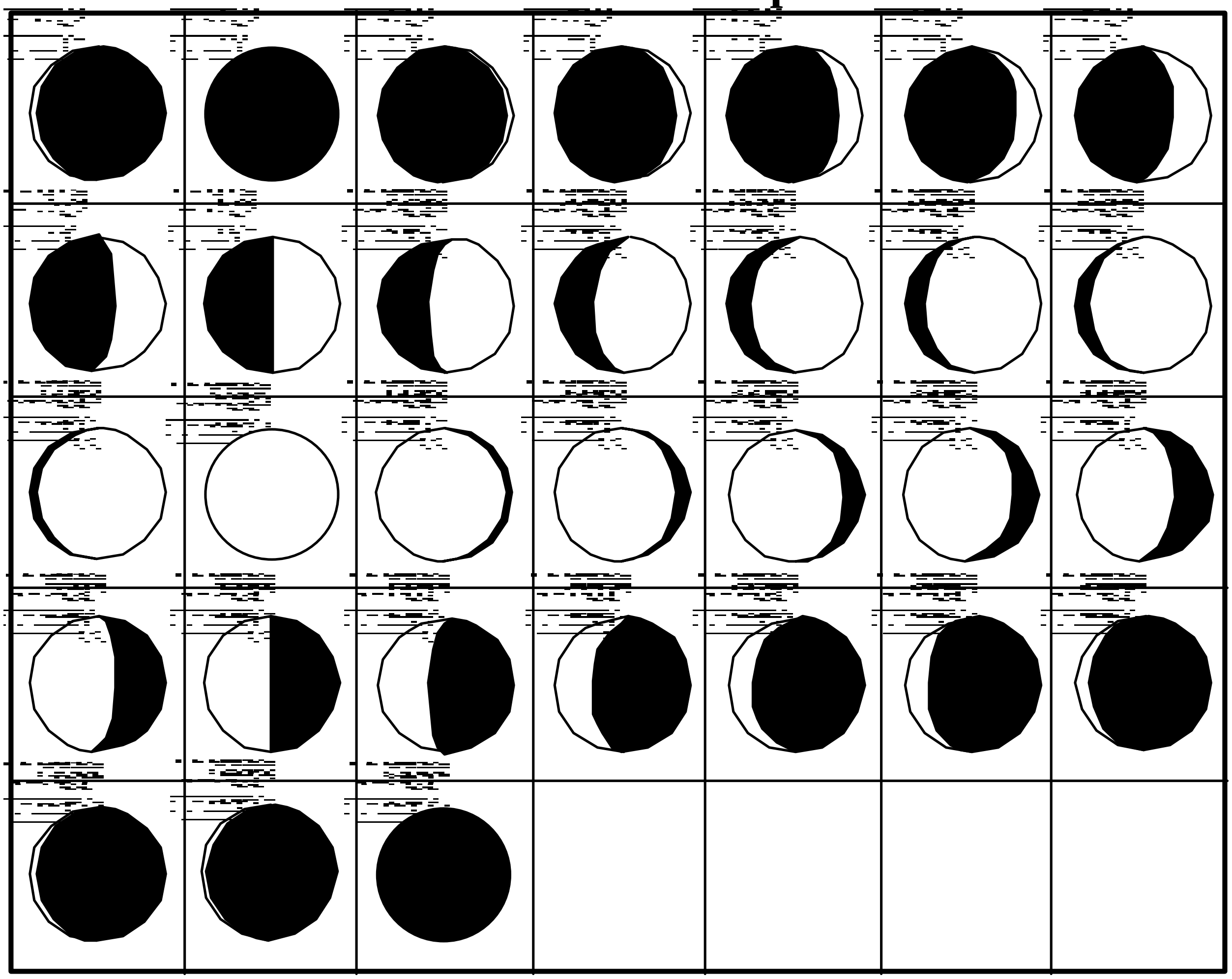

WANING CRESCENT


NEW MOON

Name: ____ *Master #17*

Date: ____

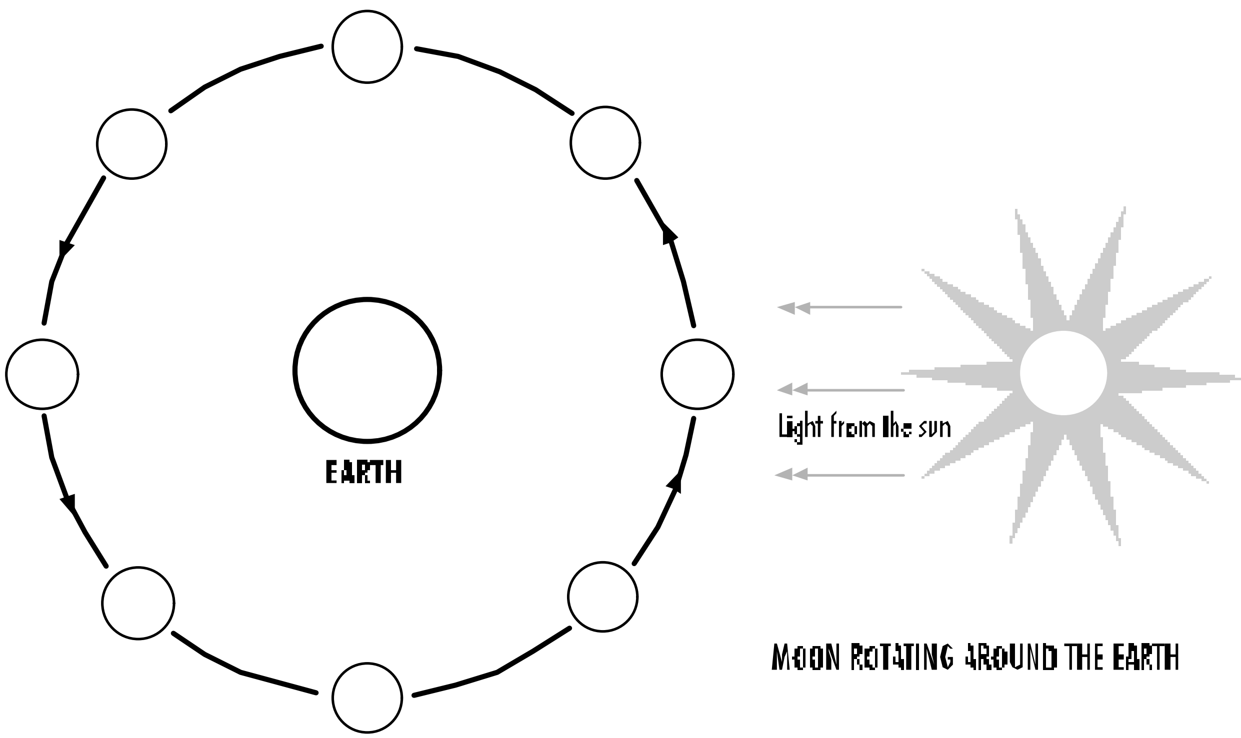
Moon Animation – Flip Book



Name: ____ *Master #18a*

Date: ____

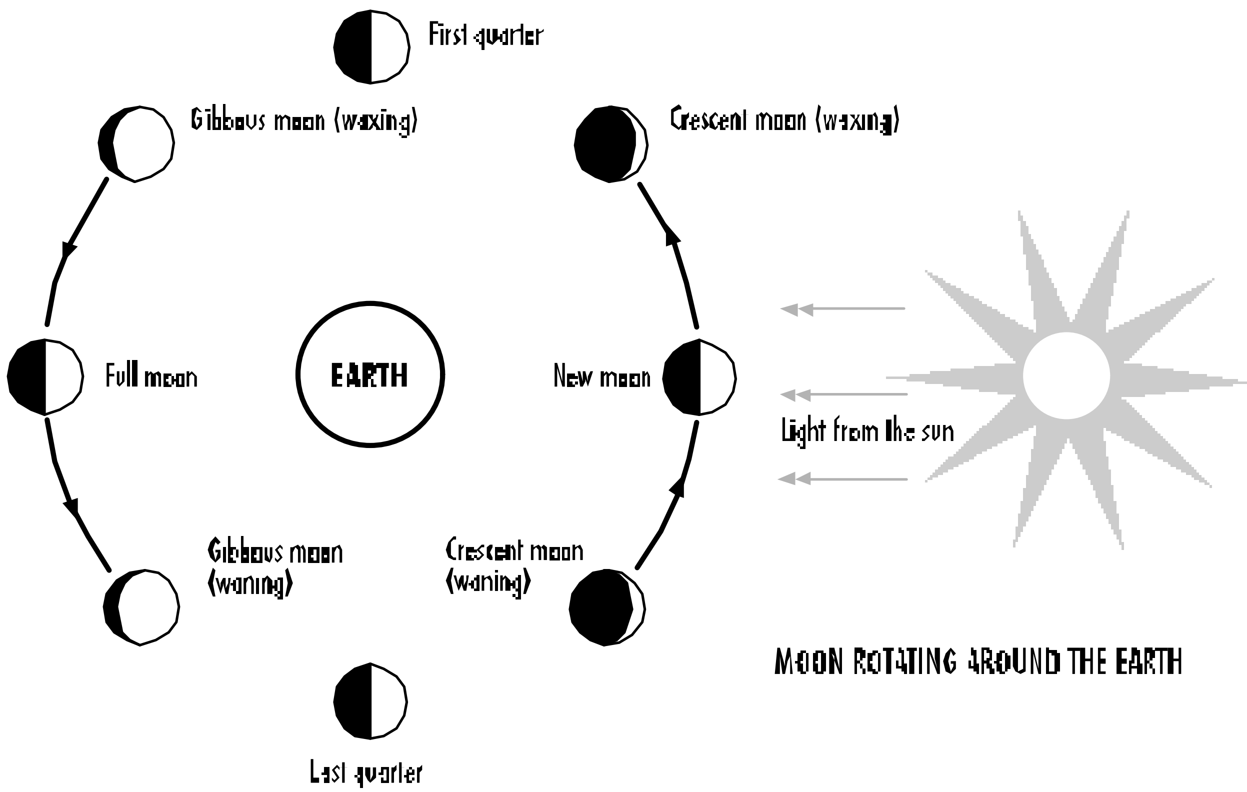
Moon Dance – Student Sheet



Name: ____ *Master #18b*

Date: ____

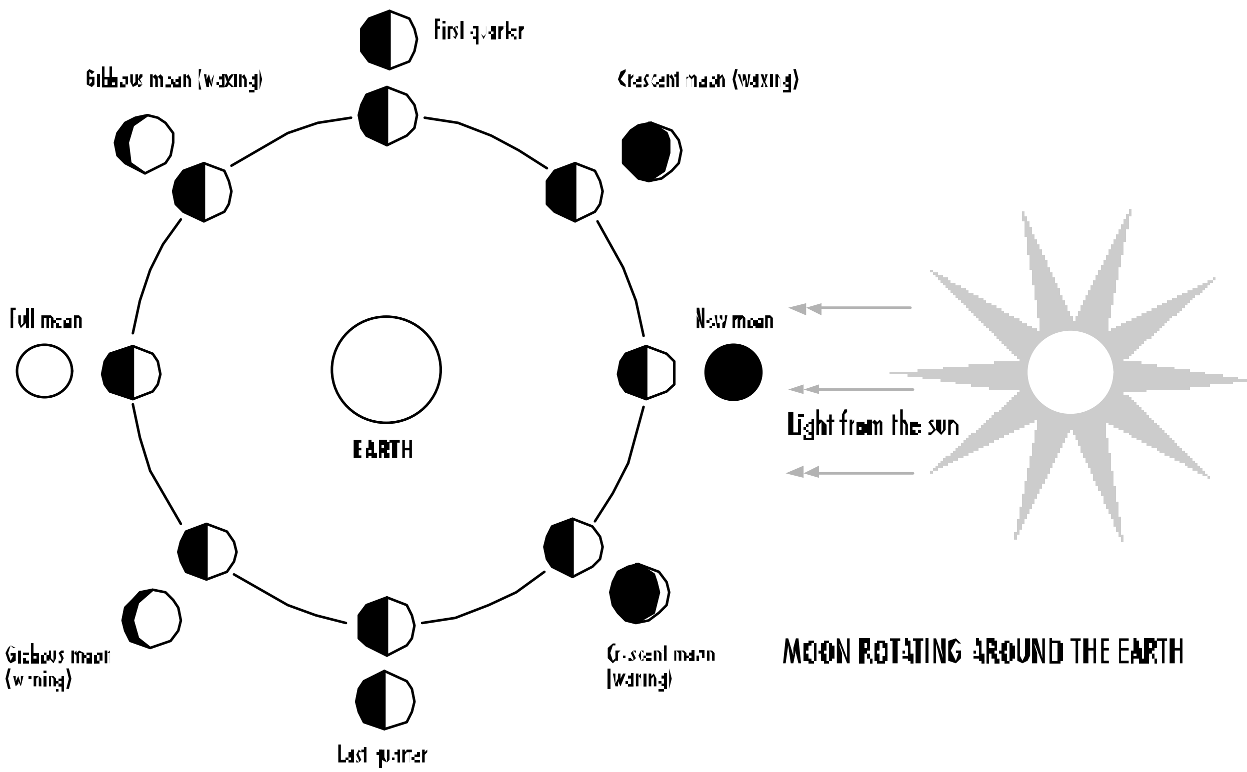
Moon Dance – Teacher Key



Name: ____ *Master #18c*

Date: ____

Moon Dance – Putting It All Together



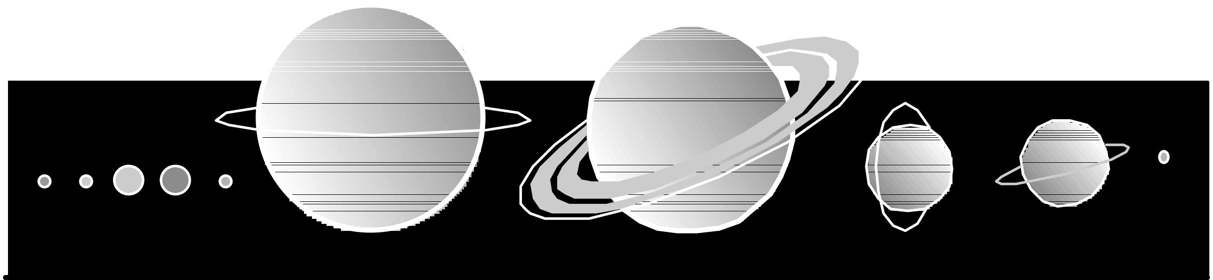
Name: ______________________________________ *Master #19*

Date: ______________________________________

Planet Research

<table>
<tr><td rowspan="2">Surface appearance:</td><td>Distance from the Sun:___________________
Period of revolution:_____________________
Diameter:________________________________
Number of Moons:_______________________
Number of rings:_________________________
Rotation period:_________________________</td></tr>
<tr><td>Weather:</td></tr>
<tr><td>Picture:</td><td>Other interesting details/facts:</td></tr>
</table>

SOLAR SYSTEM STATISTICS



CATEGORIES	Sun	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
1. Mean Distance From Sun (millions of Kilometers)	—	57.9	108.2	149.6	227.9	778.3	1,427	2,871	4,497	5,914
2. Period of Revolution	—	88 days	224.7 days	365.3 days	687 days	11.86 years	29.46 years	84 years	165 years	248 years
3. Equatorial Diameter (Kilometers)	1,390,000	4,880	12,104	12,756	6,786.8	143,200	120,000	51,800	49,528	2,330
4. Atmosphere (Main Components)	Hydrogen Helium	Virtually none	Carbon Dioxide	Nitrogen	Carbon Dioxide	Hydrogen Helium	Hydrogen Helium	Helium Hydrogen Methane	Hydrogen Helium Methane	Methane (?)
5. Moons	—	0	0	1	2	16	18	15	8	1
6. Rings	—	0	0	0	0	3	1,000 (?)	11	4	0
7. Inclination of Orbit to Ecliptic	—	7°	3.4°	0°	1.85°	1.3°	2.5°	0.8°	1.8°	17.1°
8. Eccentricity of Orbit	—	.206	.007	.017	.093	.048	.056	.046	.009	.248
9. Rotation Period	25.6 days	59 days	243 days retrograde	23 hours 56 min.	24 hours 37 min.	9 hours 55 min.	10 hours 40 min.	17 hours 12 min.	16 hours 7 min. retrograde	6 days 9 hours 18 min. retrograde
10. Inclination of Axis	7.25°	Near 0°	177.2°	23° 27'	25° 12'	3° 5'	26° 44'	97° 55'	28° 48'	120°

Inclinations greater than 90° imply retrograde rotation.

Name: ______________________________ *Master #21*

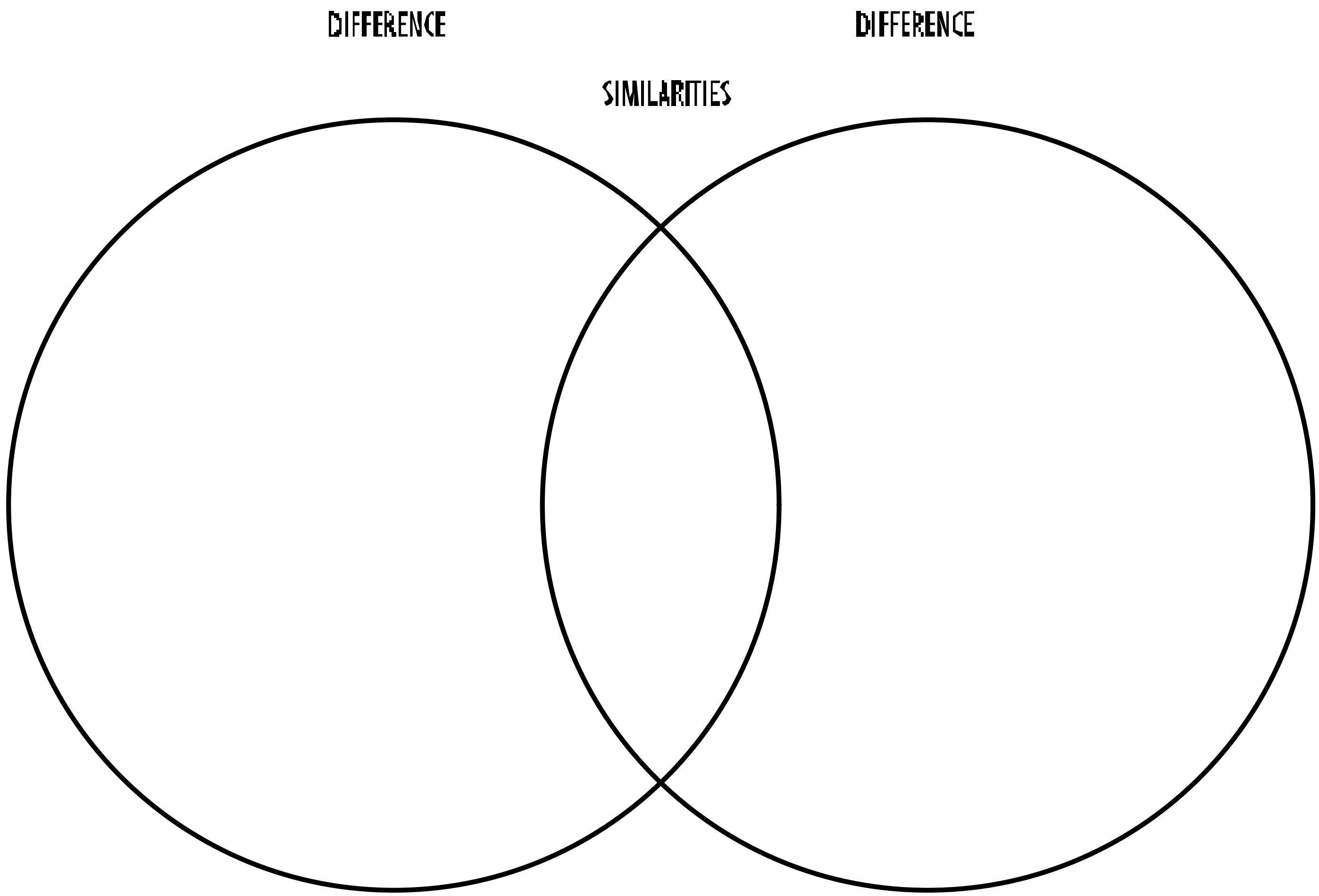
Date: ______________________________

Planet Names

Sun	**Jupiter**
Mercury	**Saturn**
Venus	**Uranus**
Earth	**Neptune**
Mars	**Pluto**

Name: ______________________________ Date: ____________________ *Master #22*

Satellites – Venn Diagram



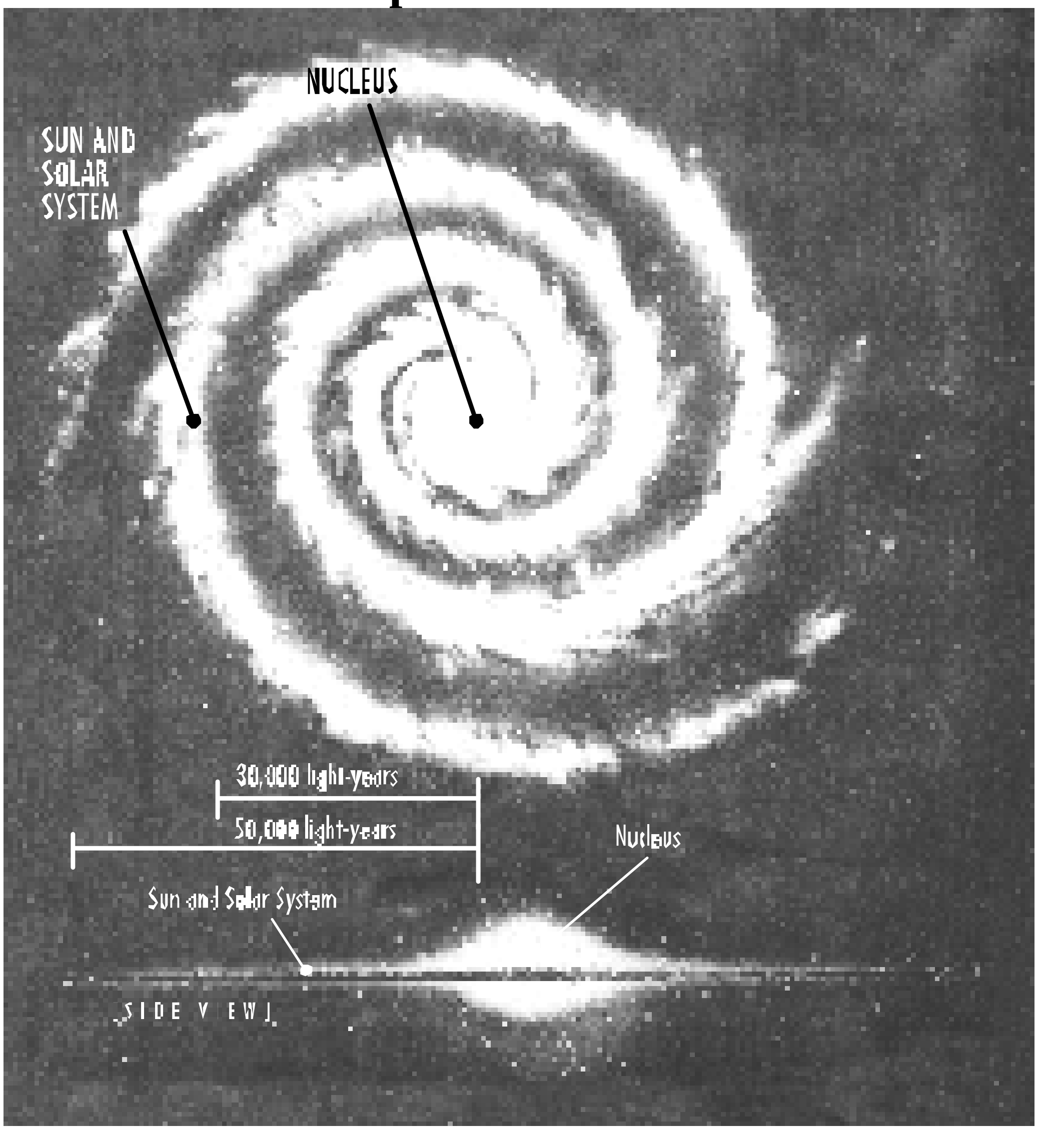
____
Name of Satellite

____
Name of Satellite

Name: ____ *Master #23*

Date: ____

Spiral Galaxies



Note:
At times, the spiral arms are not that well-defined in our galaxy, and astronomers are only taking educational guesses as to what the galaxy actually looks like. They do this by comparing our galaxy to the Andromeda galaxy which is our closest galactic neighbour and which we believe looks like the Milky Way.

Name: ____ *Master #24a*

Date: ____

Survival Story

Your mission was to rendezvous with another spaceship on the lighted surface of the Moon, but the mission was aborted due to mechanical difficulties, which forced a crash landing many miles from the other spaceship. Most of the equipment is in shambles, however the list below shows those items still intact. Identify which items are most important for your survival, by ranking them from 1 (most important) to 15 (least important), as you attempt to journey to meet the other spaceship. May the "Force" be with you!

- ☐ Portable heating unit
- ☐ Flashlight
- ☐ First aid kit
- ☐ Case of dry milk
- ☐ Silk parachute (one large piece)
- ☐ Two .45 caliber guns
- ☐ Magnetic compass
- ☐ Litres of water (10)
- ☐ Signal flares (3)
- ☐ Nylon rope (15 m)
- ☐ Dried food packs (4)
- ☐ Matches (1 box)
- ☐ Tanks of oxygen (2)
- ☐ Solar-Powered FM receiver transmitter
- ☐ Stellar map (of the Moon's constellations)

Name: ____ *Master #24b*

Date: ____

Survival Story – Key

12 Portable heating *unit (useful for dark side of Moon only)*

13 Flashlight *(useful only for dark side of Moon)*

7 First aid kit *(for injury or sickness)*

11 Case of dry milk *(nutritious source when mixed with water)*

8 Silk parachute (one large piece) *(shelter against sun)*

10 Two .45 caliber guns *(useful as self-propulsion devices)*

14 Magnetic compass *(useless- Moon probably has no magnetic poles)*

2 Litres of water (10) *(to replenish body loss)*

9 Signal flares (3) *(location marker when within sight of base ship)*

6 Nylon rope (15 m) *(help in climbing and securing packs)*

4 Dried food packs (4) *(daily food requirements)*

15 Matches (1 box) *(little or no use on the Moon)*

1 Tanks of oxygen (2) *(necessary for breathing)*

5 Solar-Powered FM receiver transmitter *(distress signaling)*

3 Stellar-Powered map *(of the Moon's constellations)*

Grade 6

Topic C

SKY SCIENCE

- MATERIAL LIST -

- Material List -

ammonia apple seed art paper *(legal sized)* balloons *(large, round)* beads beach ball black grapes black tape books *(reference, information)* brightness gauge cans cantaloupe cardboard box cartons CD-ROMS chalk clear cellophane computer and video resources construction paper *(yellow, black)* corn syrup *(dark)* crayons *(yellow)* currants dirt dry ice duo tangs envelopes file folders felt tip markers film strips fine tip markers flashlight glitter globe glue grapefruit graph paper Greek myths and Star Stories green grapes hammer ice chest lamp letter writing paper light source magazines *(old)* magnifying glass	manila tag *(regular, black)* meter stick mixing bowl *(metal)* mixing spoon *(large)* note pads orange overheads packages of stars *(gold, silver, red)* paper *(white)* paper clips paper towels pencils ping pong ball pins pins plastic garbage bags plasticine post cards pumpkin raisins recording device *(mindmap, blank recording sheet, split page, index cards)* rolled paper *(long sheets)* rulers sand scissors stapler staples star map stopper story books *(about the origins of the Earth and the Sky)* string tape tennis ball thermometer thread tin foil toothpicks travel brochure/poster water watermelon welder's glass *(#14 - optional)* wooden spoon work gloves