

Let's Do Science

Grade Six

Sky Science



Science Alberta Programs for Your Classroom



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Sky Science

Before You Begin

In this unit students will get a chance to explore the concepts of time and patterns by studying the relational changes of the Sun, Moon and stars. Students will discover how these celestial bodies influence each other and their daily lives.

Topic C: Sky Science

(Suggested time: 5-6 weeks)

This unit is best done in the fall when the nights are long and not too cold, but it can also be done in February, as winter skies are often the clearest for star gazing. Much of the data collection for this unit will need to be done at home in the evening. Therefore, a letter home, requesting parental assistance with this type of homework, is a good idea. Flexibility is an important part of the long-range planning for this unit. A flexible class schedule will allow for certain activities to be done when you have a clear day, such as observing the reflection of the sun.

If a class night-viewing of the sky is planned, it could be as part of a whole school event. If it's a class event, parent volunteers could be recruited to help. A local astronomy club could be invited to bring a variety of telescopes and binoculars on tripods. Check your local observatory for free evening night-sky guided viewing.

Background Information

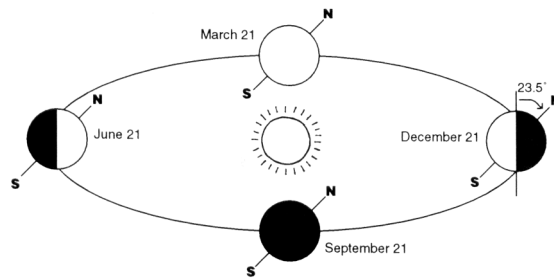
The sky has always been a source of wonder and inspiration for us. We have ancient rock paintings and bone carvings, Egyptian hieroglyphs and Babylonian cuneiform records that document our earliest fascination with the luminous objects that appear overhead in the daytime and nighttime skies. We no longer look to these as gods who control our destinies but feel humble, nonetheless, when we consider the vast distances between objects in space, and what a minuscule part of the universe our solar system represents. Our star, the Sun, is only one of 1011 stars in our galaxy (the Milky Way galaxy) and, as far as we can tell at present, the universe contains individual galaxies numbering in the **billions!**

Our ability to detect and count galaxies in deep space has been greatly enhanced by the Hubble Space Telescope. The Hubble Telescope is situated in orbit high about the thick layer of Earth's atmosphere, so it can detect things at a distance with far greater clarity than telescopes at ground level. This state-of-the-art telescope that also sends us exceptional pictures of objects closer to home, like the giant planets Jupiter and Saturn, is the latest in a long line of instruments and observing techniques astronomers have developed to expand our knowledge of the universe. Traditional telescopes magnify and focus images using visible light, but there are also telescopes that "see" the universe at infrared, radio and even X-ray wavelengths. Astronomers can analyze the energy emitted or reflected by gaseous objects in space (stars, nebulae, planetary atmospheres and comet tails) to determine their chemical make-up. And we have sent probes with and without crews to planets and satellites within our own solar system, bringing back rocks from the Moon, contour mapping the surface of Venus, analyzing samples of Martian soil for signs of life, and discovering planetary rings, an active volcano and a host of moons around Jupiter and Saturn that are completely undetectable from Earth.

We have come a long way from the ancient belief that the Earth is the centre of the universe around which all else revolves. And yet, when you go outside and observe the motions of the Sun, Moon, planets and stars for any length of time, it is easy to see how our ancestors came to this erroneous conclusion—everything in the sky appears to be circling the Earth! Each morning the Sun rises in the east, travels across the southern half of the sky in a great arc and sets in the west. And at night the planets, individual stars and *constellations* (groups of stars that form an identifiable "picture") follow a similar routine. As convincing as the illusion is that the Earth holds still while everything goes around it, in actuality the effect is brought about because Earth is spinning from west to east, completing one rotation every 24 hours with respect to the Sun.

On Earth's surface, we experience alternating periods of light and dark (day and night). If the Earth's axis of rotation through the North and South poles were oriented straight up and down with respect to the plane of the Earth's orbit, we would have 12 hours of day and 12 hours of

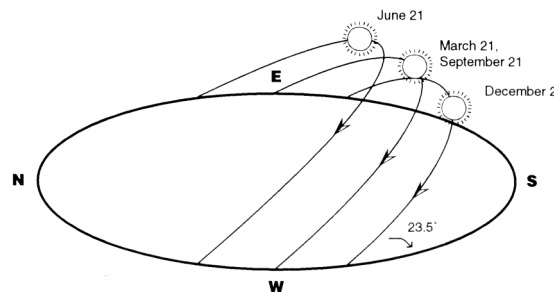
Figure 1.
Earth's orientation to the Sun.



night all year long. But we live on a lopsided planet with its axis tilted 23.5° off to one side, so we get a lopsided distribution of daylight hours over the course of the year (see Fig. 1).

As Earth travels around its orbit, the North and South poles point away from the Sun to varying degrees at different times of the year, creating the seasons. In the northern hemisphere, our pole points most directly away from the Sun on December 21, the shortest day of the year (*winter solstice*): we see only 7 to 8 hours of sunlight in Alberta (7 in the extreme north of the province, 8 in the far south). Due to the minimal hours of daylight and the low angle of the Sun in the southern sky, our winter climate is extremely cold. Just the opposite conditions exist six months later, when the North Pole points toward the Sun. On June 21, the longest day of the year (*summer solstice*), the noonday Sun is high in the sky and we experience over 16 hours of warm summer sunlight (see Fig. 2). And

Figure 2.
Daily path of the Sun across the sky.

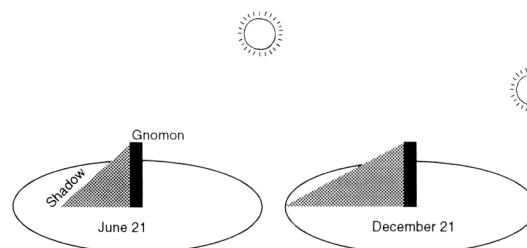


on two days of the year, March 21 (*vernal equinox*) and September 21 (*autumnal equinox*), the Earth is situated such that we receive exactly 12 hours of daylight and 12 hours of darkness.

You can keep a daily record of the Sun's direction and height in the sky by constructing a simple sundial or sun stick (*gnomon*). Watch the shadow cast by the upright. You will see the longest shadows in the morning and evening and the shortest shadow at noon. If you mark the position of the

top of the shadow at noon over the course of several weeks, you will see the shadow get shorter and shorter as you approach June 21, then begin to lengthen again (see Fig. 3).

Figure 3.
Sun's height in the sky.

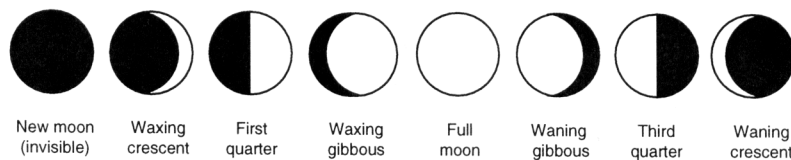


Earth is not the only object illuminated by the Sun's light. In fact, all the objects in our solar system—the Moon, asteroids, comets, the planets and their moons—are visible to us courtesy of the Sun. If you use a small telescope or a pair of high-power binoculars, you can sometimes see the

planet Venus (the brightest star-like object in the nighttime sky) as a fat crescent, proving it shines by reflected light.

Of course, the Moon provides us with a much closer, more spectacular demonstration of reflected sunlight. It orbits the Earth once every 29.5 days, with varying amounts of its illuminated surface visible from Earth at different positions in its orbit. Although the effect is all a matter of perspective, we say the Moon is “going through its phases.” At *new moon*, we can't see the Moon at all for about three days because it is situated in the same direction as the Sun. (**Note:** Never stare directly at the Sun or look at the Sun through a telescope unless it is equipped with a proper safety filter.) When the Moon continues in its orbit, it appears as a thin crescent just above the western horizon at sunset, then appears to grow in girth (*waxes*), night after night until it reaches *full moon* at the opposite side of its orbit a half month after new moon. Then, from our perspective, it appears to shrink in girth (*wanes*) from day to day, until it reaches new moon again. (We often miss seeing the Moon in its waning phases because it is in the sky during the daytime for most of this period and not easily spotted.) There are several designations for the size and shape of the phases between new moon and full moon (see Fig. 4).

Figure 4.
Phases of the Moon.



The best time to view features on the Moon is during the partial phases when the sunlight hits the lunar craters and mountains at an angle and casts distinct shadows.

Craters—the ancient sites of gigantic, explosive meteor impacts—are the most outstanding features on the lunar surface. Astronomers have also found excitingly unique and exotic conditions on the surfaces of each of the planets in our solar system (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto, in order of increasing distance from the Sun).

- **Mercury's** surface temperature is hot enough to melt lead.
- **Venus** has a poisonous atmosphere that is dense enough to crush space probes as they descend toward the planet's surface.
- **Mars**, “the red planet,” sports the largest volcano in the solar system (Olympus Mons); a long deep canyon that puts our Grand Canyon to shame; white polar caps covered in frozen water and dry ice (frozen carbon dioxide) and two small, cratered moons named *Phobos* and *Deimos*.
- **Jupiter**, a gaseous planet almost massive enough to radiate light and

count as a star in its own right, is the largest of the planets and is prominent in the nighttime sky flanked by four of its largest moons. When the *Voyager* spacecraft flew by Jupiter, we found each of these moons has its own unique character. For example, *Io* has the only known active volcano in the solar system not on Earth, and *Europa* appears to have a cracked, frozen surface that covers a vast liquid ocean.

- **Saturn**, another “gas giant” has a complex set of ice particle rings circling its equator, and an impressive entourage of moons, including *Titan*, the largest moon in the solar system.
- **Uranus** turns about an axis that is tilted through 98° . It appears to spin laying on its side!
- **Neptune** is so far out and so cold that substances that are gases on Earth (e.g., oxygen, nitrogen, methane) are frozen solid on its surface.
- **Pluto** is so small that some astronomers refer to it as nothing more than an overgrown asteroid that should never have been classified as a planet in the first place. It is certainly on the same scale as the larger moons within the solar system.

Mercury, Venus, Mars, Jupiter and Saturn are easy to see with the unaided eye if you know where to look. In fact, they are as bright as (in Venus' case, even brighter than) the most luminous stars in the sky. If the diversity we see among the planets of our own solar system is any indication of the vast range of conditions we will encounter as we move farther into space, we have a truly fascinating future of exploration ahead of us.

Elementary Science Program of Studies

General and Specific Learner Expectations

The following general and specific learner expectations have been taken directly from the 1996 Elementary Science Program of Studies. The specific learner expectations (SLEs) are referred to by number in the second column of the activities table.

General Learner Expectation

Students will be able to:

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

Specific Learner Expectations

Students will be able to:

1. Recognize that the Sun and stars emit the light by which they are seen, and that most other bodies in space, including the Earth's Moon, the planets and their moons, comets and asteroids, 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 not be viewed through a telescope, light filter or directly without taking proper 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 use of improvised models. An improvised model might involve such things as a table lamp or a sponge ball.
9. Recognize that the other eight known planets that revolve around the Sun have characteristics and surface conditions that are different from the Earth, and identify examples of those differences.
10. Recognize that Earth and other planets have moons, and identify examples of similarities and difference in characteristics of those moons.

Cross-curricular Connections

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

Language Learning

- Research planets, moons, and technology.
- Create posters, audio-visual or computer assisted presentations (for example, PowerPoint).

Art

- Paper-mâché models of Sun, Moon and planets.

Mathematics

- Measure, chart and graph the angle of the Sun and the length of the day.
- Add and subtract time.

This topic is also related to the grade 4 unit Light and Shadows.

Children's Alternative Frameworks

Some of the alternative frameworks students operate under include:

- the objects in the sky move, not the Earth (e.g., the Sun goes up and down and around the Earth);
- the Earth is closer and farther away from the Sun during different seasons;
- the shadows are longest at noon; and
- the Moon is “larger” when it is “closer” to the Earth at moonrise.

It is important to try the preliminary activities suggested for this unit in order to see what alternative ideas students bring to this unit.

Activities

Classroom teachers have identified the following activities that may be done to address the Specific Learner Expectations (SLEs) in the Program of Studies. The list is not prescriptive and teachers may select activities that are most appropriate for their students.

Activities have been listed under two headings: Key Activities and Extension Activities. Key activities are supported by authorized resources and identify “powerful and practical” means for achieving learner expectations. Extension activities represent alternative ways of achieving or supporting learner expectations.

Key Activities

Key Activity	SLE	Print Resources	Essential Materials	Comments
Describing and drawing initial ideas about the Earth and space		<i>Earth, Moon and Stars Teacher's Guide, Activity 2, The Earth's Shape and Gravity</i> , p. 9	paper, pencil	This introductory activity is done to determine students' prior knowledge.
Investigating movement of the Sun	5	<i>Innovations in Science, Level 6, Sky Science (Star Light, Star Bright)</i> , p. 23 <i>Explorations in Science, Level 6, Cosmic Connections (Tracking the Sun)</i> , p. 15	small Mylar or steel mirrors, Plasticine, tape, black construction paper, scissors; do not use mirror chips	The size of the hole must be kept small. A sunny day is required to track the path of the Sun. Warning: students must not look at the Sun.
Observing shadow changes over time	6	<i>Innovations in Science, Level 6, Sky Science (Sun Time)</i> , p. 27 <i>Explorations in Science, Level 6, Cosmic Connections (High Noon)</i> , p. 17	thin sticks or dowels, chalk	Begin the activity early in the morning on a bright, sunny day.
Observing movement and faces of the Moon	3, 7, 8	<i>Explorations in Science, Level 6, Cosmic Connections (The Moon on the Move)</i> , p. 23 <i>Earth, Moon and Stars Teacher's Guide, Activity 3, Observing the Moon</i> , p. 17		Requires long-term observation and record keeping. The series of activities helps explain student observations.
Creating a model of lunar phases	7	<i>Innovations in Science, Level 6, Sky Science (One Lunar Lap)</i> , p. 16 <i>Explorations in Science, Level 6, Cosmic Connections (A Changing Face)</i> , p. 19 <i>Earth, Moon and Stars Teacher's Guide, Activity 4, Modelling Moon Phases and Eclipses</i> , p. 25	bright light source, clean, white volleyball	Begin this activity a few weeks before the onset of a new lunar cycle. It requires long-term observation and record keeping.

Key Activity	SLE	Print Resources	Essential Materials	Comments
Creating a model to explain star movement	2, 3	<i>Explorations in Science, Level 6, Cosmic Connections (Star Shift), p. 30</i> <i>Innovations in Science, Level 6, Sky Science (Where, Oh Where?), p. 30</i>	overhead projector blackline masters 4 and 5, (in <i>Innovations, Sky Science Teaching Notes</i>)	Several observations of stars should occur before this activity is done. Send a letter home.
Using models to interpret changes in day length and seasonal changes	6	<i>Explorations in Science, Level 6, Cosmic Connections (The Earth in Space), p. 25</i>	globe, Plasticine, pin or toothpick	
Constructing instruments to measure the Sun's altitude	6	<i>Explorations in Science, Level 6, Cosmic Connections (Can You Measure Up?), p. 36</i>	wood, nails, screws, eye screws, glue, washers, string	
Observing another planet's moon	10	<i>Innovations in Science, Level 6, Sky Science (Mission to Moon X), p. 8</i>	Styrofoam ball, coloured fabric, coloured thread, toothpicks, nails, sparkles, etc.	Requires teacher to make a "Moon" from supplies with a multi-featured surface. It's best if the Moon can be suspended outside. Students may decide to use binoculars, telescope, camera, flashlight, etc.
Building a sunscope to make safe, indirect observations of the Sun	1, 4, 11	<i>Innovations in Science, Level 6, Sky Science (Spot the Sun), p. 20</i> <i>Innovations in Science, Level 6, Sky Science (Star Light, Star Bright), p. 64</i> <i>Explorations in Science, Level 6, Cosmic Connections (Sun-Camera), p. 12</i> <i>Solar System Teacher's Guide by D. Finsnad.</i>	shoe box, aluminum foil, black construction paper, white paper, scissors, tape, needles large paper, markers	Looking directly at the Sun will severely damage your eyes. Students should not "shine" sunlight towards other students' eyes.

Extension Activities

Extension Activity	SLE	Print Resources	Essential Materials	Comments
Investigating ancient models of the world	3	<i>Earth, Moon and Stars Teacher's Guide, Activity 1, Ancient Models of the World</i> , p. 3	large sheets of paper or cardboard, crayons or markers	This activity is suitable to use as an introduction to the unit.
Investigating our ability to see in the dark	11	<i>Explorations in Science, Level 6, Cosmic Connections (Becoming a Sky Detective!)</i> , p. 10	flashlight, materials such as cloth, balloons and cellophane in a variety of colours	
Projecting an image of sunspots	11	<i>Innovations in Science, Level 6, Sky Science (Spot the Sun, Extending the Experience)</i> , p. 22	telescope, binoculars	Caution: Students must not look directly at the Sun. The telescope or binoculars are used to project an image, <i>not</i> for student viewing. This activity should be used as a demonstration and only done with close supervision.
Making detailed drawings of the Moon's surface	11	<i>Innovations in Science, Level 6, Sky Science (Extending the Experience)</i> , p. 19	binoculars, telescope, paper, pencils	
Making star clocks	2, 3	<i>Earth, Moon and Stars Teacher's Guide, Activity 5, Making a Star Clock</i> , p. 33	black construction paper, gold stars or yellow stick-on labels, masking tape, hole punch, paper fasteners, scissors	
Using star maps to interpret the night sky	3, 12	<i>Earth, Moon and Stars Teacher's Guide, Activity 6, Using Star Maps</i> , p. 41	black paper, gold stars or yellow stick-on labels, masking tape	An alternate source for star maps is the periodical <i>Science and Children</i> published by the National Science Teachers' Association.
Making and interpreting planetary models	12	<i>Explore! A Book of Science. Student Resource Book 6</i> , p. 40-43.	black paper, silver pens, white-out, coloured markers	Create pictures of the universe and galaxy following the photographs by using white-out on black paper and colouring it.

Extension Activity	SLE	Print Resources	Essential Materials	Comments
Inventing an “alien”	9	<p>The Telus World of Science, Calgary, no longer runs the annual Invent an Alien contest. However, they do have resources and materials on their website so you can run the competition at your school.</p> <p>http://www.calgaryscience.ca/new/educators/specialevents/inventalien.php</p>		Students research a given planet or moon and then construct an alien that may be able to live on the planet or moon.
Turning the classroom into a planetarium		<i>Innovations in Science, Level 6 (The Sky’s the Limit), p. 39</i>	materials used throughout the theme	
Observing the varying brightness of stars	1	<i>Explorations in Science, Level 6, Cosmic Connections (Starlight, Starbright), p. 28</i>	cardboard, clear cellophane, tape or glue	

Assessment

For a broader discussion of science classroom assessment techniques see *Assessing Student Learning* in the introduction of this publication on p. 15. Good places to begin looking for the unit-related ideas are *Explorations in Science* assessment handbooks, *Innovations in Science* teaching notes, Unit tests and Portfolio ideas, Alberta Education sample tests at www.education.gov.ab.ca and Alberta Assessment Consortium at www.aac.ab.ca

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