

Integrated Science Lesson Plan Format

Title

Moon phases

Grade Level

3rd

Benchmarks (Michigan Curriculum Framework)

V.4.2. Describe the motions of the Earth and Moon around the Sun.

Objectives

- A student will be able to qualitatively sketch the position of the Sun, Earth and the Moon at the principle phases.
- A student will be able to cite appropriate observations as evidence to justify their sketches.

Assessment (formative and summative)

Pretest question: see page 14.

Posttest (quiz): see page 16.

Formative assessments are imbedded in the exercises. See the description of the exercises for details.

Homework extension: see page 15.

Materials and Setup

- Lamp with no lampshade and 60 Watt light bulb.
 - One per class (Wal-Mart or local thrift store)
- 2-inch diameter white Styrofoam balls, available from craft stores.
 - One per every two students.
 - Distributed to pairs of students as mentioned in the procedure.
- Room darkening shades
 - Depending on windows in the classroom, paper, shades or blinds may need to be employed to make the room semi dark. Complete darkness is not needed and poses several drawbacks (students can not read in the dark).
- Calendar pages covering the month of the lesson and at least one month after.
 - One page for each student to record their assigned observation dates.
 - At least one reference calendar per group for extending the model.
- Moon phase cards
 - Cards with a sketch of each of the principle phases and the name of the phase.
 - One set per group of students.
- Pictures of the Moon at various phases giving the time and the position in the sky.
 - Students will generate their own pictures but it is helpful to have some on hand to make up for bad weather and incorrect observations.
 - The pictures and rise and set times of the Moon can be obtained from the United States Naval Observatory Astronomy Applications Department. (United States

Naval Observatory, 2005) The teacher can use these pictures and data to construct “falsified” observations based on the model to supplement student’s observations.

- One per student
- Bear in the Big Blue House video or DVD, Jim Hansen video, distributed by Beuna Vista Home Video. and Video playback equipment. Any episode will work. Check local library for titles.

Safety

Follow appropriate safety procedures relative to the lamp you use. No other special safety considerations need to be made.

Requisite Knowledge/skills for students

Students should understand that the rise and set of the Sun is due to the rotation of the Earth. They should be able to draw a top view (looking down on the north pole) diagram of the Earth and the Sun showing the correct location of Michigan at sunrise, sunset, noon and midnight.

Procedure

This lesson is a guided inquiry lesson. The role of the teacher is to facilitate the students constructing their own knowledge. This means the teacher provides appropriate questions to start the students investigating, guides the students to appropriate observations that will help them gather the needed evidence and selects applications of the knowledge constructed so that students will refine, correct and extend their knowledge. The students are responsible for constructing their own knowledge. In each activity below we will suggest appropriate teacher questions. These questions are used to guide the students and to help the teacher evaluate the progress of the students. Exercise 1 is adapted from and Exercise 2 is inspired by Physics by Inquiry (McDermott, 1996).

Engage:

Pretest. Administer the pretest. The pretest should be collected and marked for correctness but not given a grade. In the lesson the pretest will be returned to the students and they will be asked to rework the pretest.

Moon observations. Students should work in groups of 4-8 to collect this information. They can work in smaller groups for the rest of the exercises. Using a calendar page the group should sign up to take turns observing the Moon. There should be one student on each day for at least one month. Be sure to allow at least six weeks to complete the lesson. The students will need occasional reminders to make their Moon observations. If a student misses their day to observe, their group can share data with another group. On their assigned day the students should attempt to observe the Moon at least two times at least two hours apart. They should record the time, location in the sky and shape of the Moon at each of the two times. If the moon is not in the sky when they try to observe it, they should record that on their data sheet. The observation sheet is helpful in making the observations.

When making observations, students will often be concerned because they do not see the Moon out at night. This happens on cloudy nights and when the Moon is not full. Ask the students to

record the time that they looked for the Moon and that no Moon was visible. You can also ask the students if they have ever seen the Moon up when the Sun was up. They probably have.

Explore:

As a class, have all the students hang their observations along the chalkboard or a wall in chronological order. There should be two observations from each group on each day of the month. There will probably be missing days where the weather was bad or students did not find the Moon. Let students try to build their model of the Moon phases first. If they cannot build the model, then use your supplemental observations to correct problems and fill in the blanks.

With the Moon observations on the wall have the students complete (in groups of 2-4) Exercise 1 at the end of the exercise discuss the results with each group. Students may work on the next activity while you circulate through the room. Ask students to describe their findings to you. Also ask students when they expect the next full Moon to come. They should be able to use the period of the cycle (they will find 28-30 days) and the full Moon in their class observations.

As small groups give the students a set of Moon phase cards. Exercise 2 asks the students to arrange the cards in the order that they appear in their observations and then to start the cycle in different spots. After this exercise, the students should know the names of the phases. In later exercises they will be asked to apply this knowledge. If they have trouble later, have them re-visit exercise 2.

You will most likely have to break this lesson up over several days. This is a convenient place to stop for the day.

Explain:

Experiment 3 takes place in a dark room, turn off the overhead lights and turn on the lamp in the center of the classroom. Have the students arrange themselves around the lamp in pairs so that each pair has a clear view of light from the lamp. If your class is large, have some students wait and do the activity after the first students have finished. If your room has windows that allow a lot of light, you may need to cover part of the windows.

During this experiment the teacher should circulate through the room checking on the progress of individual pairs. Ask the students what the phase is in the first step. If they correctly identify as third quarter, ask them how they know. They should be able to tell you either by the shape (the eastern half is illuminated) or by the position at the time of day (directly overhead at sunrise). If they can not correctly identify the phase using the shape, ask them leading questions to see that it is a third quarter. A line of questions might go like this: "Let's say your nose is Michigan. What time of day does this arrangement of the Sun and Earth correspond to? (Sunrise they should have this prior knowledge, if not ask them to talk to each other and figure out then move on to another group) Where is the Moon in the sky at this time? (Directly overhead, if they cannot answer correctly remind them that their nose is Michigan and ask them to think about it again. Let them discuss it together while you move to another group if needed.) From our observations, what is the phase of the Moon when the Moon is directly overhead at sunrise? (Here they may need to

extrapolate between two observations. You may need to help them realize that if the Moon is directly overhead at sunrise then it rises at midnight and sets at noon.)
Here is another good place to stop for the day if needed.

Elaborate (Apply, Extend):

Return the pretest to the students and ask them to re consider their answers. They should recognize their mistakes.

An Application of the model is found in the homework.

Several good extensions of the model could be used when discussing the solar system. They will not be described in this lesson plan.

Extension 1: The distance from the Earth to the Sun.

Extension 2: The phases of Venus

Evaluate:

The pre-test is a formative evaluation. It gives the students and the teacher information about the initial state of the students. The students are not expected to get the question correct. It is better if they do not answer correctly. When the pretest is returned to the students it should not be marked correct or incorrect. The students should be able to decide if they are correct or not.

Formative evaluations are described in the exercises.

The homework application and quiz question form the summative evaluations. Students should be able to complete these assignments with a bit of thought. If they can not they need to look back at the model they developed. If they have a lot of difficulty, have them work with their partners and use the ball and light to answer the questions.

Scientific Background for the Teacher

The phases of the Moon are the result of part of the Moon being illuminated by the Sun. (Hewitt, 2002) The half of the Moon that faces the Sun is always illuminated; the half of the Moon facing the Earth is visible on Earth. When the angle between the Sun and the Moon is very small, the fraction illuminated is very small. This corresponds to the new Moon phase. Angles between small and 90° are crescent phases. 90° is a quarter phase. From 90° to 180° is a gibbous Moon. 180° is a full Moon. A gibbous Moon that is nearly full will probably be labeled full by students. This is not an important difference to make. When labeling phases for children the quarter phase is the most distinct. It should be used as a point of reference.

When a quarter Moon rises at noon it is a first quarter, when it is setting at noon it is a third quarter. In a top view diagram the Moon rotates counter clockwise around the Earth.

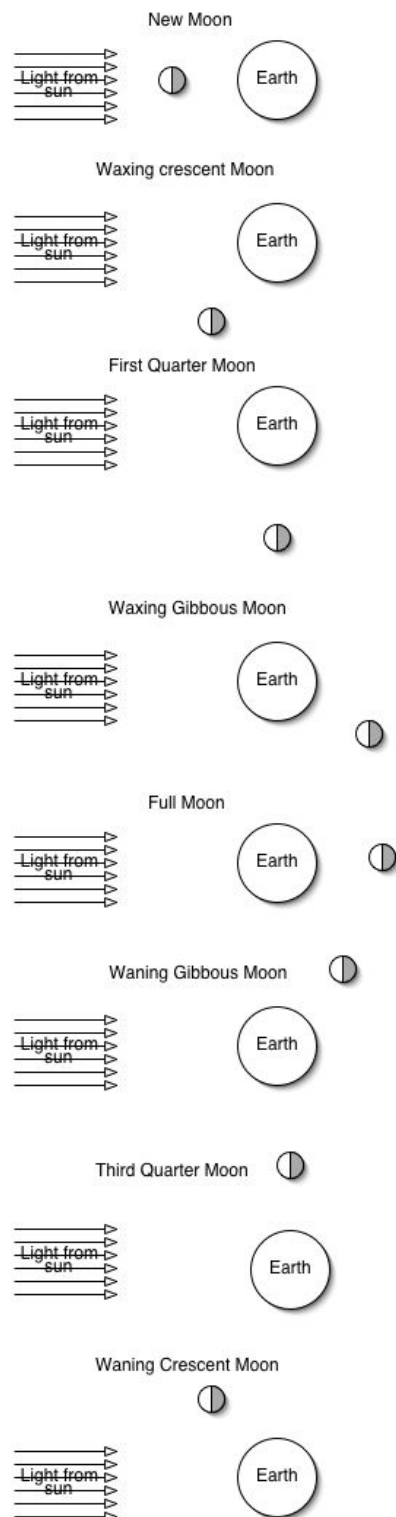
As the moon progresses from the new phase to the full phase the it is said to be waxing. As the moon progresses from the full phase to the new phase it is said to be waning.

References

McDermott, L.C. Physics by Inquiry Volume 1, (1996), New York, John Wiley & Sons, Inc.

Hewitt, P., Conceptual Physics 9th Ed., (2002), San Francisco, Addison Wesley.

United States Naval Observatory, (2005) <http://aa.usno.navy.mil/> accessed June 2005.



Time:	Draw the Moon the way it looks during your observation:
Direction:	
High or Low in the sky	

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Direction:	
High or Low in the sky	

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Moon Phases, Exercise 1

- A. Consider all the observations of the Moon your class made.
Does the Moon have the same shape every night?

Explain how you can tell. Describe specific observations that help you make this conclusion.

- B. Consider all the observations of the Moon for one day.
Does the shape of the Moon change during one day?

Explain how can you tell. Describe specific observations that help you make this conclusion.

- C. Consider all the observations of the Moon for two consecutive days.
Does the shape of the Moon change a lot between the two days or does it change just a little.

Explain how you can tell. Describe specific observations that help you make this conclusion.

- D. Consider all the observations of the Moon your class made.
Are there any days where the Moon changed shape a lot during the day?

If there are, when did it happen?

Are there any days where the Moon changed shape a lot from one day to the very next day?

If there are when did it happen?

- E. Chose a day near the beginning of your classes observations. Describe the shape of the Moon on that day.

Find another day when the Moon has the same shape. Note: sometimes the crescent Moon opens to the left; sometimes it opens to the right. These shapes are not the same. Find a shape that is exactly the same.

How many days are there between the two shapes that are the same.

3 Check your reasoning with your teacher.

Moon Phases, Exercise 2

While your group waits for your teacher to check your reasoning, get a set of Moon cards and arrange them in the order that they appear in you class Moon observations. Record this order here:

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How would the pattern of the Moon shape look if we started with a full Moon? Arrange the pattern so that it has the same order but starts with the full Moon

Full Moon							
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How would the pattern look if we started with a new Moon? Arrange the pattern so that it has the same order but starts with the new Moon

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Moon Phases, Experiment 3

In this exercise we will come to understand how the phases of the Moon are produced. With your partner get a white foam ball. There is a lamp in the center of the room. The lamp is like the Sun, the white ball will be the Moon and your head will be the Earth. With your partner, choose one of you to be student one and one to be student two. Later we will switch the rolls and do the experiment again.

One: Hold the ball in front of you at arms length. Turn your body so that the light bulb is on your left side. What Moon phase does the ball look like?

Two: While your partner is holding the ball, sketch a top view diagram that shows the lamp, the ball and your partner. On the ball, show the part that is lit up by the lamp. Next draw a top view diagram that shows the Sun, Moon, and Earth when the Moon is in the phase that looks the same as the ball. On the Moon, show the part that is lit up by the Sun.

Top View of lamp, ball, and partner

Top view of Sun, Moon and Earth in _____ phase

One: Slowly turn to the left. When the ball looks like a waning crescent Moon, stop and let your partner sketch the top view diagram

Two: Sketch a top view diagram of the lamp, ball and your partner when the ball looks like a waning crescent Moon to your partner. Next sketch a top view diagram of the Sun, Moon and Earth in the waning crescent phase.

Top View of lamp, ball, and partner

Top view of Sun, Moon and Earth in waning crescent phase

One: continue turning slowly to the left. Stop and let your partner sketch a top view diagram when the ball looks like a: new Moon, waxing crescent Moon, first quarter Moon, waxing gibbous Moon, full Moon, and waning gibbous Moon.

Two: Each time your partner stops, sketch a top view diagram of the lamp, the ball and your partner. Then sketch a top view diagram of the Sun, the Moon and the Earth in each Moon phase.

Top View of lamp, ball, and partner

Top view of Sun, Moon and Earth in _____ phase

Top View of lamp, ball, and partner

Top view of Sun, Moon and Earth in _____ phase

Top View of lamp, ball, and partner

Top view of Sun, Moon and Earth in _____ phase

Top View of lamp, ball, and partner

Top view of Sun, Moon and Earth in _____ phase

Top View of lamp, ball, and partner

Top view of Sun, Moon and Earth in _____ phase

Top View of lamp, ball, and partner

Top view of Sun, Moon and Earth in _____ phase

PRETEST

Your teacher will show you a short video clip. After watching the video clip answer this question on your own. It is not important for you to be correct, it is important that you clearly explain what you think. After we have studied the Moon, we will look back at this to see how our ideas have changed.

The clip showed Bear and Luna singing a goodbye song. The song said that the Moon comes up at the end of each day. Is this good science? Explain why or why not. Remember to clearly record your ideas so we can reflect on it later.

Bear and Luna's song is not good science because we have watched the Moon and the Moon does not come up at the end of each day. It depends on the phase of the Moon. When it is a full Moon the Moon comes up as the Sun goes down but when it is a quarter Moon the Moon comes up near noon or midnight. In the new Moon phase the Moon rises at about the same time as the Sun. We do not see this Moon because of the brightness of the Sun.

HOMEWORK

You are at a slumber party with two good friends on [DATE] (teacher: fill in a date with a gibbous Moon near a on a Friday or Saturday near the time of the assignment). At about 11:00 pm. (it is not on a school night) you see a beautiful gibbous Moon just above the eastern horizon. One of your friends proposes that you tell a Moon secret, a secret you all promise not to tell anyone except when the Moon is the same shape in the same part of the sky. It sounds cool, so you all agree. Several of your friends tell particularly good secrets that you are just dying to tell. Since you have just learned about the Moon, you decide to plan a party where you will tell the secrets.

Explain when you will hold the party.

I would hold the party at the same time of day 29 days later.

Tell how you know you should hold the party then.

We studied the Moon and we saw that the same shape repeats in 29 days. We also found that the same shape always rises at the same time. So we will need to meet in 29 days at the same time.

Make an invitation to the party. Be sure to include the time, date and place for the party.

Give credit for correct predictions and smiley faces for style and creativity.

Quiz

1. Draw a top view diagram of the Sun, the Moon, and the Earth for each of the following phases.

(For a key see the description of science for the teacher in this lesson plan)

New Moon:

Full Moon

First Quarter Moon

2. What time of day does a third quarter moonrise? Show a top view diagram to illustrate your answer. Explain your diagram.