Astronomy Merit Badge

Merit badge requirements as revised 2011
this lesson plan by Glenn Holliday
revised January 2013

During daytime teaching session

1. Do the following:

a. Describe the proper clothing and other precautions for safely making observations at night and in cold weather.

Winter observing: You need more protection from cold then when camping. Observing has no sunlight and is inactive. Plan for 20 degrees colder than the actual temperature.

b. Tell how to safely observe the Sun, objects near the Sun, and the Moon.

Indirect observing with a pinhole camera. If available, show an unacceptable solar filter, an acceptable solar filter, and a solar telescope.

c. Explain first aid for injuries or illnesses, such as heat and cold reactions, dehydration, bites and stings, and damage to your eyes that could occur during observation.

First aid for eye damage: Protect your eyes. After they are damaged, there is no first aid other than seeking immediate medical help from an eye doctor. . Symptoms: pain, blurred vision, flash blindness.

Either the sun or a laser can cause the same kind of burn to the cornea or retina. It is very similar to a sunburn. Recovery varies. See the links to additional resources for a medical article on the subject.

(2 do during nighttime session: light pollution)

3. With the aid of diagrams (or real telescopes if available), do each of the following:

a. Explain why binoculars and telescopes are important astronomical tools. Demonstrate or explain how these tools are used.

b. Describe the similarities and differences of several types of astronomical telescopes.

OTAs: Refractor, reflector, Schmidt-Cassegrain

Mounts: Altitude-azimuth, equatorial, Dobsonion

c. Explain the purposes of at least three instruments used with astronomical telescopes.

Finder, 1x sight, planisphere, charts, camera, spectroscope, reticle, alignment tools, red light

d. Describe the proper care and storage of telescopes and binoculars both at home and in the field.

(4 do during nighttime session: Identify stars and constellations)

5. Do the following:

a. List the names of the five most visible planets. Explain which ones can appear in phases similar to lunar phases and which ones cannot, and explain why.

b. Using the Internet (with your parent's permission), books, and other resources, find out when each of the five most visible planets that you identified in requirement 5a will be observable in the evening sky during the next 12 months, then compile this information in the form of a chart or table.

Made easier – no longer have to update the chart monthly

Students need to do the research and create the chart on their own.

c. Describe the motion of the planets across the sky.

(5 d. do during nighttime session: Observe a planet)

6. Do the following:

(6.a. do during nighttime session: Observe Moon.)

(6.b. do during nighttime session: Moon phases.)

c. List the factors that keep the Moon in orbit around Earth.

d. With the aid of diagrams, explain the relative positions of the Sun, Earth, and the Moon at the times of lunar and solar eclipses, and at the times of new, first-quarter, full, and last-quarter phases of the Moon.

Students need to draw the diagrams on their own.

7. Do the following:

a. Describe the composition of the Sun, its relationship to other stars, and some effects of its radiation on Earth's weather and communications.

b. Define sunspots and describe some of the effects they may have on solar radiation.

(7.c. do during nighttime session: Identify colored stars.)

8. With your counselor's approval and guidance, do ONE of the following:
Students will need to complete the project on their own.
a. Visit a planetarium or astronomical observatory. Submit a written report, a scrapbook, or a video presentation afterward to your counselor that includes the following information:

(1) Activities occurring there
(2) Exhibits and displays you saw
(3) Telescopes and instruments being used
(4) Celestial objects you observed.

List of planetariums near Rappahannock Astronomy Club

Albert Einstein Planetarium
National Air and Space Museum
Smithsonian Institution
Washington, D.C
http://www.nasm.si.edu/visit/theaters/planetarium/

Davis Planetarium
Maryland Science Center
Baltimore, Maryland
http://www.mdsci.org/shows/planetarium.html

Hopkins Planetarium
Science Museum of Western Virginia
Roanoke, Virginia
http://smwv.org/ATM/showtimes.htm#planetarium

John C. Wells Planetarium
James Madison University
Harrisonburg, Virginia
http://www.jmu.edu/planetarium/
free shows on Saturdays

Science Museum of Virginia Planetarium
Richmond, Virginia
http://www.smv.org/imaxdome.html#PlanetariumShow

List of observatories near the Rappahannock Astronomy Club

Fan Mountain Observatory
University of Virginia
14 miles south of Charlottesville, off of US-29
Each April and October, a public night is held. Tickets, which are free, are required.
http://www.astro.virginia.edu/research/observatories/

Green Bank Telescope
Green Bank, West Virginia
The Science Center is open some days
http://www.gb.nrao.edu/GBT/GBT.shtml

Keeble Observatory
Randolph Macon College
Ashland, Virginia
The Keeble Observatory will be closed for public viewing until September, when the College returns for Fall Semester.
http://www.rmc.edu/Academics/physics/keeble.aspx

Leander McCormick Observatory
University of Virginia
Mount Jefferson
Charlottesville, Virginia
McCormick Observatory is open to the public on the first and third Friday night of each month (except holidays).
http://www.astro.virginia.edu/research/observatories/

United States Naval Observatory
Washington, D. C.
The observatory has received an overwhelming number of applications for tour reservations. Due to the backlog it is not accepting any new tour requests until further notice.
http://www.usno.navy.mil/USNO

University of Maryland Observatory
College Park, Maryland
Open house on selected nights
http://www.astro.umd.edu/openhouse/index.html

b. Plan and participate in a three-hour observation session that includes using binoculars or a telescope. List the celestial objects you want to observe, and find each on a star chart or in a guidebook. Prepare an observing log or notebook. Show your plan, charts, and log or notebook to your counselor before making your observations. Review your log or notebook with your counselor afterward.

Importance of planning:

- What's visible this time of year
- Limits of observing site on horizon obstructions, light pollution
- Effect of moonlight
- Equipment suitable to types of objects you wish to observe
- Observe objects in order of their setting

c. Plan and host a star party for your Scout troop or other group such as your class at school. Use binoculars or a telescope to show and explain celestial objects to the group.

d. Help an astronomy club in your community hold a star party that is open to the public.

e. Personally take a series of photographs or digital images of the movement of the Moon, a planet, an asteroid or meteoroid, or a comet. In your visual display, label each image and include the date and time it was taken. Show all positions on a star chart or map. Show your display at school or at a troop meeting. Explain the changes you observed.

9. Find out about three different career opportunities in astronomy. Pick one and find out the education, training, and experience required for this profession. Discuss this with your counselor, and explain why this profession might interest you.

- Science – astronomer, astrophysicist
- Education – teacher, ranger, museum, creator of planetarium shows
- Support – equipment operation, image processing, computer programming
- Hardware – optics, design, construction of instruments

During nighttime observing session

(1. do during daytime session: Safety and first aid)

2. Explain what light pollution is and how it and air pollution affect astronomy.

(3 do during daytime session: Telescopes and binoculars)

4. Do the following:

a. Identify in the sky at least 10 constellations, at least four of which are in the zodiac.

If the class observing session does not cover these, students will need to show them in another observing session.

Spring:

Ursa Major, Ursa Minor, Bootes, Hercules, Corvus, Lyra

zodiacal: Gemini, Leo, Virgo, Libra, Scorpius

Summer:

Ursa Major, Ursa Minor, Bootes, Hercules, Corvus, Lyra, Cygnus, Aquila, Summer Triangle asterism (Vega, Deneb, Altair)

zodiacal: Virgo (setting), Libra, Scorpius, Sagittarius, Capricornus, Aquarius

Fall:

Ursa Major, Ursa Minor, Bootes, Hercules, Lyra, Cygnus, Aquila, Cassiopeia, Cepheus, Pegasus, Andromeda, Perseus, Cetus

zodiacal: Sagittarius (setting), Capricornus, Aquarius, Pisces, Aries, Taurus (after midnight)

Winter:

Ursa Major, Ursa Minor, Cygnus, Cassiopeia, Cepheus, Orion, Canis Major, Winter Triangle asterism: (Betelgeuse, Sirius, Procyon)

zodiacal: Pisces, Aries, Taurus, Gemini, Leo (late)

b. Identify at least eight conspicuous stars, five of which are of magnitude 1 or brighter.

A century ago an astronomer would have thought this requirement a mistake: there are no stars brighter than magnitude 1. Then we redefined that metric.

Spring

Dubhe, Merak, Mizar, Alcor, (all Ursa Major), Regulus (Leo), Arcturus, (Bootes), Altair (Aquila), Spica (Virgo), Vega (Lyra), Antares (Scorpius), Capella (Auriga), Castor, Pollux (Gemini), Deneb (Cygnus), Summer Triangle: Vega (Lyra), Deneb (Cygnus), Altair (Aquila)

Summer:

Dubhe, Merak, Mizar, Alcor, (all Ursa Major), Arcturus, (Bootes), Altair (Aquila), Spica (Virgo, setting), Vega (Lyra), Antares (Scorpius), Deneb (Cygnus), Summer Triangle: Vega (Lyra), Deneb (Cygnus), Altair (Aquila)

Fall:

Dubhe, Merak, Mizar, Alcor, (all Ursa Major), Arcturus, (Bootes), Altair (Aquila), Vega (Lyra), Deneb (Cygnus), Mirfak (alpha Persi)

Winter:

Sirius (Canis Major), Betelgeuse (Orion), Rigel (Orion), Procyon (Canis Minor), Capella (Auriga), Aldebaran (Taurus)

1st magnitude stars visible in northern hemisphere

Because modern instruments can measure star brightness in fractions of a magnitude, and measured magnitude depends of how much of the spectrum of a star is measured, different lists choose different points to divide the 1st magnitude starts from the 2nd magnitude stars. This list includes the visible energy of stars from magnitude -1.5 to 1.39. Stars of magnitude 1.4 are classified as 2nd magnitude stars. It does not include stars that are not easily viewed from the latitude of Virginia.

Name	Constellation	Best Season	Color	Size
Aldebaran	Taurus	Winter	Red	Giant
Altair	Aquila	Summer	White	Dwarf
Antares	Scorpius	Summer	Red	Supergiant
Arcturus	Bootes	Spring	Orange	Giant
Betelgeuse	Orion	Winter	Red	Supergiant
Capella	Auriga	Winter	Yellow	Giant
Deneb	Cygnus	Fall	White	Supergiant
Fomalhaut	Picis Austrinus	Fall	White	Dwarf
Pollux	Gemini	Winter	Yellow	Giant
Procyon	Canis Minor	Winter	White	Giant
Regulus	Leo	Spring	Blue	Dwarf
Rigel	Orion	Winter	Blue	Supergiant
Sirius	Canis Major	Winter	White	Dwarf
Spica	Virgo	Spring	Blue	Dwarf
Vega	Lyra	Summer	White	Dwarf

c. Make two sketches of the Big Dipper. In one sketch, show the Big Dipper's orientation in the early evening sky. In another sketch, show its position several hours later. In both sketches, show the North Star and the horizon. Record the date and time each sketch was made.

If class observing is not long enough for both viewings, students will need to make the observation and sketches on their own.

d. Explain what we see when we look at the Milky Way.

Students need to answer this on their workbooks.

(5. a.. do during daytime session: List the names of the five most visible planets.)

(5. b. do at home: Find out when each of the five most visible planets that you identified in requirement 5a will be observable)

(5. c. do during daytime session: Describe the motion of the planets across the sky.)

5. d. Observe a planet and describe what you saw.

6. a. Sketch the face of the moon and indicate at least five seas and five craters. Label these landmarks.

Students need to draw the diagrams on their own.

6. b. Sketch the phase and the daily position of the Moon at the same hour and place, for four days in a row. Include landmarks on the horizon such as hills, trees, and buildings. Explain the changes you observe.

Made easier – no longer a week of watching it.

Students need to observe and sketch on 4 days on their own.

(6. c. do during daytime session: List the factors that keep the Moon in orbit around Earth.)

(6. d. do during daytime session: Explain the relative positions of the Sun, Earth, and the Moon at the times of … eclipses, and at the times … phases of the Moon.

(7. a. do during daytime session: Describe the composition of the Sun ...)

(7. b. do during daytime session: Define sunspots ...)

7. c. Identify at least one red star, one blue star, and one yellow star (other than the Sun). Explain the meaning of these colors.

Blue Regulus (Leo), Vega (Lyra)

Red: Antares (Scorpius), Arcturus (Bootes), Betelgeuse (Orion)

Yellow:Albireo (Cygnus), Pollux (Gemini), Capella (Auriga), Castor (Gemini)

Explain why there are no green stars

Spring:

Blue: Regulus (Leo)

Red: Arcturus (Bootes)

Yellow: Capella (Auriga)

Summer:

Blue: Vega (Lyra)

Red: Antares (Scorpius), Arcturus (Bootes)

Yellow: Albireo (Cygnus)

Fall:

Blue: Vega (Lyra)

Red: Arcturus (Bootes)

Yellow: Albireo (Cygnus), Capella (Auriga), Castor (Gemini), Pollux (Gemini)

Winter

Blue: Rigel (Orion), the brighter Pleiades, Bellatrix (gamma Ori)

Red: Betelgeuse (Orion), Aldebaran (Taurus)

Yellow: Capella (Auriga), Castor (Gemini), Pollux (Gemini)

Different authorities give different colors for some stars. For example, Arcturus is claimed to be both red and yellow. It appears to the eye as a red star, but it is not very red. In the Secchi classification, Arcturus is in Class II, which are yellow stars. In the Spectral Class classification, Arcturus is in Class K, which are orangish stars slightly cooler than the Class G yellow stars.

(8. project)

(9. do during daytime session: Find out about three different career opportunities in astronomy)

Schedule to Present Astronomy Merit Badge

Requirement #	Subject	Activity	Materials	# hours
Daytime class session				
5.c	Motion of planets	Walk through	MB pamphlet	0.3
3.a	Why telescopes/binoculars	Show equipment	Telescope, binoculars	0.5
1.a	Clothing / safety for observing	Discuss	MB pamphlet	0.2
1.b	Safety observing Sun	Discuss	MB pamphlet, filter, solar telescope	0.2
1.c	First aid	Discuss	MB pamphlet	0.2
3.b	Types of telescopes	Discuss	Photos of equipment	0.3
5.a	Planet phases	Walk through	Diagram of phases	0.3
3.c	3 instruments used with telescopes	Show	Finder, planisphere, charts	0.3
3.d	Care of telescopes	Show	Telescope, binoculars	0.2
6.c	Explain Moon's orbit	Walk through	MB pamphlet	0.3
7.a	Describe Sun	Discuss	MB pamphlet	0.3
7.b	Describe sunspots	Discuss	MB pamphlet	0.3
9	Careers	Discuss	List of careers	0.5
6.d	Explain eclipses and phases	Walk through	MB pamphlet	0.3
Nighttime observing session				
2	Light pollution / air pollution	Show	MB pamphlet	0.3
4.c	Dipper first observation	Show	Diagram of rotation, story of Dippers, paper and pencil	0.2
4.a	10 constellations	Show	List of current sky	0.5
4.b	8 bright stars	Show	List of current sky	0.3
4.d	What is Milky Way	Show	MB pamphlet	0.3
7.c	Identify colored stars	Show	List of stars	0.5
4.c continued	Dipper second observation	Show	same as for first observation	0.2
5.d	Observe a planet	Show	Sky chart	0.2
6.a	Sketch the Moon	Show	Moon map, paper and pencil	0.3
Homework				
5.b	Chart / planets visible	Describe how to look up	The Sky, Web almanac, paper and pencil	0.5
6.b	Sketch Moon phase for 4 days	Discuss	Sky chart, pencil and paper	1.2
8.a	Visit planetarium	Describe how to find one	List of planetariums and observatories	4
8.b	3 hour observing	Show	Observing plan	3
8.c	Troop star party	Discuss how to do one		3
8.d	Club star party	Refer to RAC	RAC schedule	3
8.e	Astrophotos	Give references	Links to astrophotography tutorials	10
Class Hours Needed				4.2
Nighttime Observing Hours Needed				2.8
Homework Hours Needed				11.7
Total Hours Needed				**18.7**