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ABSTRACT

This autoinstructional unit deals with the study of stars, constellations, and planets as part of a General Science and/or Earth Science program for students in high or middle school. Twelve behavioral objectives are identified. The equipment needed, the time suggested as adequate, and a sample of a final test that can be administered are included in the monograph. The script uses slides and an accompanying worksheet to facilitate the learning experience. A bibliography of four references is given. (EB)

SKY STUDY

Prepared By

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June 30, 1973

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TEACHER'S GUIDE

PACKET NUMBER	522 R
SUBJECT	General Science and/or Earth Science
TITLE	Sky Study
LEVEL	High - Middle
BEHAVIORAL OBJECTIVES	1. Differentiate between names of stars and constellations. 2. Identify and describe parts of the celestial globe and realize how these parts relate to the sky around us. 3. To set the globe for the latitude of Newark, Delaware, as well as date and time. 4. Locate objects in our sky by right ascension and compass direction. 5. Trace the path of the sun, as well as other stars, through the heavens as a result of earth rotation and revolution. 6. Identify and classify stars magnitude (brightness). 7. Predict and locate prominant constellations and stars that are visible in Newark at various dates and times. 8. Compare the location of stars and star groups at various dates and times in Newark. 9. Explain why the position of planets are not placed on the globe. 10. Predict length of daylight in Newark at various times during the year.

BEHAVIORAL OBJECTIVES	11. Identify a few stars by drawing imaginary lines from key stars to various areas in the sky. 12. Measure angular distance between prominent stars in the sky.
EQUIPMENT	Celestial globe Cassette tape - tape recorder Slides, 13 Slide projector
TIME	45 minutes
SAMPLE EVALUATION	Work sheet
SPACE REQUIRED	Carrel
BIBLIOGRAPHY	Trinklein, F. E. and Huffer, C.M. Modern Space Science, New York, Holt, 1961. Rand McNally Celestial Globe instruction manual. Cram Celestial Globe instruction manual. Baker, R. H., Astronomy. D. van Nostrand Company, Inc.

SCRIPT

GENERAL AND/OR EARTH SCIENCE
SKY STUDY

You are now beginning project Sky Study. During the next few days you will learn to:

a. Tell the difference between the names of prominent stars and constellations.

b. Identify and describe parts of the celestial globe and realize how these parts relate to the sky around us.

c. Set the globe for Newark as well as date and time.

d. Locate objects in the sky by right ascension, declination and compass direction.

e. Trace the daily and yearly path of the sun and other stars through the sky.

f. Identify and classify stars by brightness.

g. Predict and locate prominent constellations and stars that are visible in Newark at various dates and times.

h. Compare the location of stars and star groups at various dates and times in Newark.

i. Predict length of daylight in Newark at various times during the year.

j. Identify a few stars by drawing imaginary lines from key stars to various areas of the sky.

Study SLIDES #1 and #2 and observe the celestial globe at your

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working station.

Set the globe so that the movable metal ring, which is the horizon ring, is parallel to the table. The solid black or blue line on the surface of the globe represents the celestial equator. Place the horizon ring directly in line with the celestial equator.

The north celestial pole is now at the top of the globe and the south celestial pole is at the bottom of the globe.

Surrounding the north celestial pole is the plastic time scale and directly beneath, drawn on the globe, is the date scale.

The line which is tilted at an angle of 23 1/2° to the celestial equator and crosses the equator at 2 points is called the ecliptic.

The metal ring circling the globe from the north to the south celestial pole represents two celestial meridians.

Study SLIDE #3. This shows an example of a constellation which is defined as a group of stars that form a pattern in the sky. Now refer to SLIDE #4. This shows an example of a star which you can think of as being a celestial body capable of giving off its own light.

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Study SLIDE #5. This shows that the celestial equator, which is half-way between the North and South celestial poles, separates the heavens into a northern celestial sphere, located above the equator, and a southern celestial sphere, located below the equator.

Refer to the question sheet if you understand what has been presented thus far. If you are confused, replay the tape. If you are still confused, make arrangements for personal help from your teacher.

Questions #1 and #2 have listed the names of bright stars. The stars listed in question #1 are located in the northern celestial sphere, and in #2, all the stars are located in the southern celestial sphere.

Your job is to list the constellation in which each of the stars is located. Turn off the recorder and work on questions #1 and #2.

When you have completed the problem, you may turn on the recorder.

Your answers to questions #1 and #2 should be as follows:

#1 - Star	Constellations
Regulus	Leo
Arcturus	Bootes
Vega	Lyra
Altair	Aquila

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Pollus	Gemini
Capella	Auriga

#2 - Star	Constellation
Rigil	Centaurus
Sirius	Canis Major
Achernar	Eridanus
Formalhaut	Piscus Austrinus
Antares	Scorpius
Mira	Cetus

Now move the celestial equator about two inches above the horizon ring. Note that the celestial equator is marked off in hours and minutes at ten minute intervals and that the celestial meridians are marked off in degrees - 0^{o} - 90^{o} north and south. Study SLIDES #6 and #7 which shows the aforementioned facts.

Look at SLIDE #8. Rotate the celestial globe until the "0" hours on the equator is directly in front of you. The "0" hour point can be called the point of origin. (This is where the system of accurately describing the position of stars or constellations in the sky begins.)

Also, at this zero point, three separate scales intersect - right ascension, declination, and the ecliptic.

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You are now ready for a few more definitions. Listen carefully to the following definitions and locate on the globe the information I will discuss with you.

Right ascension measures the angular distance along the celestial equator from the vernal equinox (which is the position of the sun on March 21) to the hour circle of a star. Refer to SLIDE #9.
Declination - measured along a celestial meridian. This scale measures the distance along a celestial meridian from 0^{o} - 90^{o} north or south. Study SLIDE #10 and locate this scale on the globe.
Ecliptic - shows the day to day change of position of the sun in the heavens. Refer to SLIDE #11 as well as the globe.

Replay these definitions and restudy SLIDES #9, 10 and 11. If you are confused, make arrangements to see me.

If you now think you understand everything I have been telling you, refer to question #3 on your question sheet. List the name of the star located at each designated point in the sky. Turn off the recorder until you finish question #3.

Your answers for question #3 should be:

a. Canopus

b. Daneb

c. Pollux or Castor

d. Procyon

e. Formalhaut

Rework any questions that you answered incorrectly.

Refer to question #4 on your worksheet and list the Right Ascension and Declination of the stars which are listed.

Turn off the recorder and work on question #4. Turn on the recorder when finished.

Giving yourself a leeway of plus or minus ten minutes of right ascension and plus or minus 2° of declination, your answers to question #4 should be:

a. 4 hours 30 minutes 16°N.

b. 13 hours 20 minutes 11°S.

c. 1 hour 35 minutes 57°S.

d. 19 hours 47 minutes 8°N.

e. 5 hours 50 minutes 7°N.

Rework any questions you have answered incorrectly. Listen again to the taped instructions if you are confused on Right Ascension and Declination. Then rework questions #3 and #4. Turn off recorder until finished.

Remember you find the daily location of the sun in the heavens on

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the imaginary line called the Ecliptic.

Now look at your question sheet. You are ready for problems #5, 6, 7 and 8. Turn off recorder until you have completed these problems.

Your answers to questions #5-#8 should be:

		Right Ascension	Declination
#5	a.	00 hour	0°
	b.	6 hours	23°N.
	c.	12 hours	0°
	d.	18 hours	23°S.

#6 a. 2 hours or 30° per month.

b. $30 \text{ days} \overline{)120 \text{ min.}}$ 4 min. of movement per day

#7 Aldebaran is not visible this time of the year because it is too close to the sun.

#8 a. Spica

b. Antares

Rework any questions that you missed. Make arrangements to see the teacher if you need additional help on any of these problems.

If you have correctly answered all problems so far, you are ready to

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learn how to adjust the globe for the latitude of Newark, (approximately 40°) as well as time and date.

a. Place the globe with the celestial North Pole at the top.

b. Place the horizon ring parallel with the table and parallel or in line with the equator.

c. Line up the declination scales on the globe surface with 12:00 noon facing the north point of the horizon ring and 12:00 midnight facing towards the south point on the horizon.

d. Swing the celestial North Pole of the globe down toward the north point of the horizon ring until the celestial North Pole is the same number of degrees above the north point on the celestial horizon as your location on the earth (approximately 40° angle). The zenith is the top of the celestial sphere and the nadir is the bottom of the celestial sphere.

e. Adjust the globe so that north on the horizon ring faces toward true north.

You now have set the celestial globe for Newark, Delaware. Study SLIDE #12. If you understand how to set the globe for location, you are ready to set it for date and time. You do this by rotating the globe until the desired day of the month on the date scale comes directly in line with the desired hour on the plastic time disc.

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Refer to SLIDE #13.

The surface of the celestial globe represents the heavens above and round you. Your position is theoretically in the center of the globe standing on an imaginary planent, Earth.

You are directly under the zenith and above the nadir. You can see any object in the sky located above the celestial horizon (moveable metal ring).

The local meridian is an imaginary line extending through the celestial sphere from the north point on the horizon through the celestial North Pole to the south point on the horizon.

If you understand what I have just told you, you are ready to attack a few more problems. Refer to your problem sheet for questions #9 - #16. Turn off the tape recorder and do not turn it on until you work these problems.

Your answers to problems #9 - #16 should be:

Problem # 9 a. East

b. West

c. For our latitude -

Some stars never set (circumpolar).

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Some stars never rise.

Some stars will rise and set.

Problem #10 a. No

b. The big dipper is a circumpolar group of stars. It never moves below the horizon at our latitude.

Problem #11 Slightly east of north.

Problem #12 The dipper rises in the sky and at a particular point moves toward the horizon. This is caused by the rotation of the earth.

Problem #13 a. 15^{o} - 20^{o} above the north east horizon.

b. Midway in the sky in the north east

c. Pointer stars almost overhead in line with an imaginary line in the sky called the local meridian

Problem #14 a. 6 hours 52 minutes

b. 12 hours 40 minutes

Problem #15 a. Capella

b. Auriga

c. Aldebaran

d. Taurus

e. Betelgeuse

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f. Orion

g. Rigel

h. 3

Problem #16	Right Ascension	Declination
a.	Sirius - 6 hours 40 minutes	16°S.
	Procyon- 7 hours 30 minutes	5°N.
	Pollus - 7 hours 30 minutes	32°N.

b. All three are visible

Sirius - low in the sky in the southwest.

Procyon- high in the sky in the southwest.

Pollus - high in the sky in the east.

If after reworking any missed problems, you cannot get what I consider the right answer, please make it a point to see me for help.

Make sure your globe is set for Newark. Remember stars rise in the east and set in the west. Your point of observation is in the middle of the globe. You are facing north, and all the areas above the horizon ring are visible from Newark.

Locate the star Pollux. Refer to your question sheet and answer questions #17 - 23. Turn off the tape machine and do not turn it on until you have answered this new set of questions.

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Your answers to questions #17 - 23 are:

#17 - between 5 P.M. and 6 P.M.

#18 - 1:00 A.M.

#19 - a. April 1 at 8:00 P.M. the big dipper is now higher in the sky and is located east of north.

b. Either Castor, Pollux or Regulus would be excellent answers.

c. Regulus - S.E.
Arturus - E.
Pollux - W.
Betelgeuse - S.W.
Rigel - S.W.

#20 - a. Regulus or Procyon

b. West

c. E. or S.E. high in the sky.

d. S.E. low in the sky

e. A little north of east near the horizon.

#21 - Vega

#22 - Deneb

#23 - Capella

If you have successfully completed all of the assignments and understand what you have been doing, you are ready for your final test.

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If you are confused, replay the tape and try to relate the instructions I have been giving you with the slides, celestial globe and problems #1-23.

If you are still confused, come to me.

When you feel you know what you are doing, refer to your question sheet and solve the problems #1-50.

Please turn off the recorder.

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STUDENT QUESTION SHEET

1. Star — Constellation

Regulus

Arcturus

Vega

Altair

Pollux

Capella

2. Rigil

Sirius

Achernar

Formalhaut

Antares

Mira

3. List the name of the star located at the below listed right ascensions and declinations.

	Right Ascension	Declination	Star Name
a.	6 hrs 22 min	52° 39 min South	
b.	20 hrs 39 min	45° 1 min North	
c.	7 hrs 30 min	32° 2 min North	
d.	7 hrs 35 min	5° 24 min North	

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	Right Ascension	Declination	Star Name
e.	10 hrs 4 min	12° 18 min North	
f.	22 hrs 53 min	29° 59 min South	

4. State the precise location in the sky of the following stars.

Star	Right Ascension	Declination
Aldebaran		
Spica		
Achernar		
Altair		
Betelgeuse		

5. Give the right ascension and declination of the sun on the following dates.
   a. March 21 (beginning of spring)
   b. June 21 (beginning of summer)
   c. September 23 (beginning of fall)
   d. December 22 (beginning of winter)

6. How far does the sun move along the ecliptic
   a. every month?
   b. every day?

7. Why isn't the star Aldebaran visible in Newark on May 30?

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8. Which star is closest to the sun in

   a. October (use any date)?

   b. December 1?

9. Rotate the globe clockwise (east to west) and follow the apparent movements of the stars and constellations.

   a. Direction of stars rising -

   b. Direction of stars setting -

   c. What in general do you notice about the ability for us in Newark to observe all the stars and constellations listed on the globe?

10. a. Does the big dipper ever set?

    b. Explain why you answered this question as you did.

11. Describe the position of the big dipper on 10 p.m. November 15.

12. How does the apparent clockwise movement of the celestial hemisphere, which is caused by earth rotation on its axis, affect the position of the big dipper?

13. Describe the position of the big dipper November 15 at

    a. midnight

    b. 3 a.m.

    c. 7 a.m.

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14. Calculate the right ascension and declination of the sun on

    a. July 4 -

    b. October 1 -

15. Set the globe for February 1, 8:50 p.m.

    a. Which bright star is nearest our zenith at this time?

    b. Name the constellation in which this star is located.

    c. Which star is slightly west of south of the star mentioned in problem (a)

    d. Constellation of the star mentioned in problem (c)

    e. Which star is a little lower in the sky and east of south of the star mentioned in problem (a)

    f. Name of the constellation of the star which pertains to problem (e)

    g. Name the star in the same constellation mentioned in problem (f) but is located lower in the constellation and directly south in the Newark sky on the date and time mentioned for all calculations in problem 15.

    h. Number of stars in Orions belt.

16. a. List the right ascension and declination of Sirius, Procyon, and Pollux.

    b. Are any of these stars visible in Newark on February 1 at 8:00 p.m.? Also, if any are visible, describe where they would be found in our night sky.

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17. What time will the star Pollux rise on January 1?

18. A star is at its culmination point when it is located at the highest point in the sky that it will ever reach. When it is at this point, it is located on an imaginary line in the sky called the local meridian. At what time will Pollux be at its culmination point in Newark on January 1?

19. Set the globe for Newark, April 1, 8:00 p.m.
    a. Compare the position of the big dipper at the above mentioned date and time with its position at 8:00 p.m. January 1.
    b. Name the star closest to the zenith.
    c. Describe the precise location in the Newark sky of Regulus, Arcturus, Pollux, Betelgeuse, Rigel.

20. Set the globe for Newark, May 1, 9:00 p.m.
    a. Name the bright star in the southwest
    b. Describe the position of Pollux
    c. Describe the position of Arcturus
    d. Describe the position of Spica
    e. Describe the position of Vega

21. Name the bright star nearest the zenith between 9-12 p.m. in July.

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22. Name of the star nearest the zenith between 9-12 p.m. in September.

23. Name of the star nearest the zenith in December.

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FINAL TEST

1. On what date is the bowl of the big dipper directly above the celestial pole at 9 p.m. in the Newark area?

2. What is the right ascension and declination of the star δ (Delta) ursae majoris?

3. At what date is Antares at its culmination point at 9 p.m.? Also, what is the angular distance of this star from the zenith on that date for Newark?

4. Describe verbally the position in the sky in reference to the stars of a planet with a right ascension of 5 hr. 30 min. and a declination of 24^{o}N.

5. At what time is Orion directly in our southern sky and on the local meridian on March 1?

6. When Orion has been found in the sky, how can it be used to find
   a. Sirius?
   b. Procyon?

7. Do Orion and Auriga rise and set at the same time? Explain.

8. At what date is Deneb on the local meridian at 9 p.m.? Also, at this time, what is its angular distance from the zenith?

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9. What is the rising time and position of rising of Orion on October 21?

10. Geometric form in the sky presented by Vega, Deneb, and Altair? Also, what season of the year are these stars most prominent?

11. Name of the constellation directly east of Andromeda.

12. Name of the star which is northwest of Orion.

13. Which of the following stars are circumpolar for our latitude?

    a. Arcturus

    b. Canopus

    c. Capella

    d. Southernmost star in Draco

14. Name of the bright star slightly north of the tail of Hydra.

15. What is the position of Corona horenlis in the Newark sky in the early evening hours in October?

16. Name of the constellation in which the vernal equinox is located.

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17. How many degrees is the ecliptic tilted to the celestial equator?

18. Which first magnitude star is closest to the sun on Dec. 25?

19. Name of the constellation that is near the zenith at 10 a.m. on January 19.

20. Name of the constellation which is on the north point of our horizon at noon on October 1?

21. Which constellation sets with the sun and at the same point in the sky on August 1?

22. Which star rises first - Rigel or Sirius?

23. Approximate length of daylight in Newark on January 20.

24. Which constellation is on the local meridian and above the celestial equator at 6 a.m. on March 5?

25. Time and position of sunset on August 31.

26. Name of the first magnitude star at 14 hours of right ascension and 20°N declination.

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27. If the planet Saturn in the month of December is located in the constellation Pisces at 10 p.m. December 1, what area of the sky would you observe to find Saturn?

28. Name of the most prominent star in the constellation Canis Major.

29. What area of the sky would you observe on December 15, at 10 p.m. to locate

    a. Taurus?

    b. Auriga?

30. On December 6, the planet Mars rises in the east at about 2 a.m. In which constellation is it located at this time?

31. What is the position of the planet Venus at 10 p.m. Christmas Eve?

32. Which area of the sky are most of the bright stars located on December 5 at 10 p.m.?

33. Precise location of the sun on December 21 at noon in the Newark sky,

34. Magnitude (brightness) classification of Rigel.

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35. Name of the small semi circle of stars between Hercules and Bootes.

36. List the names of all first magnitude stars in Ophiuchus constellation.

37. Set the globe for a March evening. From the three star belt of Orion, extend to the southeast an imaginary line through the sky. Which bright star do you find along this imaginary line?

38. Set the globe for an April evening. At this time which constellation is closest to the local meridian, in line with the pointer stars of the big dipper, and is in a position away from polaris. Remember the local meridian is an imaginary line in the sky which extends from the north point on the horizon through the celestial north pole to the south point on the horizon.

39. Extend a 30^{o} arc from the end of the handle of the big dipper in Ursa Major. Which bright star does the arc point to?

40. Set the globe for October 20, 10 p.m. for Newark.
    a. Draw an imaginary line from polaris through the square of Pegasus, continue this line to near the

southern horizon. Which first magnitude star does this procedure help you locate?

b. Draw an imaginary line diagonally off the northwest corner of the square (body) of Pegasus. Which first magnitude star do you find?

c. Extend an imaginary line westward from the α and γ stars at the base of the square. Which first magnitude star do you locate?

41. Set the globe for Newark February 20, 10 p.m. Now locate Orion (The Hunter).

a. Which star do you find if you draw a diagonal imaginary line from his belt up into the sky and to the right?

b. Draw an imaginary line diagonally from his belt down and to the left. Which star did you locate?

42. Draw a gentle arc towards the zenith from Sirius through Procyon. Which bright stars will this procedure help you find?

43.-50. List the names and describe the positions in the Newark sky tonight at 11 p.m. of the dominant constellations, and bright stars.

ANSWER KEY TO FINAL TEST

1. About April 10-25
2. 12 hr. 10 min. 57°N.
3. July 10-25 about 60° - 68° from the zenith
4. Midway between the β (Beta) and ζ (Zeta) stars of Taurus
5. 6-7 P.M.
6. a. Draw an imaginary line off the α ε ζ stars of Orions belt.

   b. Procyon, Betelgeuse and Sirius connected by imaginary lines form a triangle.
7. No, Auriga will rise before Orion and set after Orion.
8. First part of September - 3° - 6° from the zenith
9. 9-10 P.M. in the east
10. Triangle - summer
11. Perseus
12. Aldebaran
13. a. No.

    b. No.

    c. No.

    d. Yes
14. Spica
15. Low in the sky west or north west
16. Pices
17. 23 1/2°
18. Antares

ANSWER KEY TO FINAL TEST

19. Lyra, Cygnus, or Hercules

20. Cassiopsia

21. Cancer

22. Rigel

23. Between 9-11 hours

24. Ophiuchus, Camelopardus, Hercules, Draco

25. 6-7 P.M. north of west

26. Arcturus

27. South to southwest

28. Sirius

29. a. High in sky south to southeast
    b. East near the horizon

30. Virgo

31. You can not figure this answer with the data given.

32. Southeast

33. 23^{o} - 26^{o} above the south horizon on the local meridian

34. Brighter than first

35. Corona borealis

36. None

37. Sirius

38. Leo Major or Minor

39. Arcturus or Spica

40. a. Formalhaut
    b. Deneb
    c. Altair

ANSWER KEY TO FINAL TEST

41. a. Aldebaran

    b. Sirius

42. Castor, Pollux, Capella

43 - 50. Answers will vary depending upon the date these problems are solved.