Submissions for the next academic year accepted through November 1.

Application for Course Acceptance as a Core Curriculum Course Required for Bachelor's Degree

Click to enter date.
8/20/2020

TABLE #1	General Information	
Course Title:	SCIE 1250 – Life In The Cosmos	
Course Description as listed in the current FSU Catalog:	This general studies Astronomy course guides students in observing and understanding the make-up and evolution of the universe. Observations and comprehension of the cosmos are examined historically from ancient civilizations to continuing modern exploration, and scientifically from the human views of the heavens to galaxies and beyond. This course allows students to discover how nature works and is modeled by science so they can see how the entire cosmos has been necessary to made possible our life on earth. Occasional night sessions.	
Prepared by:	Galen Hansen	Full-time
Preparer email address:	ghansen@fairmontstate.edu	
Course Coordinator:	Galen Hansen	Full-time
Course Coordinator email:	ghansen@fairmontstate.edu	
Core Curriculum Category Outcome:	Category 8 - Natural Science with Critical Thinking	
Enter ALL course outcomes: **Note: If there are multiple outcomes this cell may spread onto another page. If that occurs, move Table #2 about course outcomes onto a new page.**	General Studies Outcome 8: Students will demonstrate proficiency with scientific content and data analysis to address real world problems, and recognize the limitations of the scientific process. Outcome 1. Students will demonstrate proficiency with the scientific content of Astronomy, including retention of terms, definitions and concepts. Outcome 2. Students will demonstrate proficiency with data collection and observations using appropriate equipment and record-keeping during class and lab activities. Outcome 3. Students will demonstrate proficiency with the use of analyzed data to develop and test hypotheses that address real world problems. Outcome 4. Students will use scientific content and data analysis to recognize the limitations of the scientific process.	

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Course Outline

I. Introduction: Where are we now?
Day 1 – Location of Earth
Dimensions, general makeup of the university
Day 2 – View from Earth
Earth Coordinates, viewing the sky, mapping the stars

II. Effects of Space on Earth Life
Day 3 – The Celestial Sphere
Celestial coordinates, cosmic views
Day 4 – The Ecliptic Plane
Zodiac constellations, seasons, climate
Day 5 – Time
Clocks, time zones, calendars

III. Our Nearest Neighbors
Day 6 – The Moon
Phases, Eclipses, Tides
Day 7 – The Planets
The wanderers, roots of astronomy, retrograde motion
Day 8 – Tests 1

IV. The Ascent of Man
Day 9 - The Copernican Revolution
The roots of science, Keplers laws
Day 10 – Galileo's Advances in Science
Telescopes, changing theories, power struggles
Day 11 - Newton's Laws
Gravity, force, laws of motion
Day 12 – Light
Electromagnetic spectrum, energy & temperature

V. Discovering the Nature of Matter
Day 13 – Matter
Atoms, molecules
Day 14 – The Sun
Solar spectrum, solar structure and properties
Day 15 – Fusion
Hydrostatic equilibrium, energy output
Day 16 – Test 2

VI. Discovering the Nature of Stars
Day 17 – Determining Distance in Space
Apparent and absolute magnitude, luminousity
Day 18 – HR Diagram
Star temperature, size, mass
Day 19 – Types of stars
Main sequence, massive, median, red dwarf
Day 20 – Lifetime of Stars
Intersteller medium, birth, life, death

VII. Evolution toward Mankind – (A) The Universe
Day 21 – Age of The Universe
Big bang, red-shift, universe expansion, Hubble constant
Day 22 – Galaxies
Structure, types, motion, dark matter
Day 23 – Age of Galaxies
Main-sequence turn-off, open and globular clusters
Day 24 – Test 3

VIII. Evolution toward Mankind – (B) Earth Matter
Day 25 – Star Dust
Massive stars, supernovas, planetary nebula, stellar birth revisited
Day 26 – Stellar Nurseries
Intersteller medium, protostars
Day 27 – Origin of Our Solar System
Protostars, protoplanets, radioactivity
Day 28 – Life on Earth Begins
Goldilocks zone, circular orbit, neighbors
Day 29 - Development of Life on Earth
Geological time, photosynthesis, carbon cycle
Day 30 – Continuing Ascent or Ride the Wave?
Role of science, education, culture and
Faith in the continuing evolution of humans

Final Exam – Test 4

Course Outcome and Measures

General Studies Outcome 8: Students will demonstrate proficiency with scientific content and data analysis to address real world problems, and recognize the limitations of the scientific process.

Course Outcomes:

1. Students will demonstrate proficiency with the scientific content of astronomy, including retention of terms, definitions and concepts.

   Assessments: Tests, quizzes homework.

2. Students will demonstrate proficiency with data collection and analysis using appropriate equipment and record-keeping during class and lab activities.

   Assessments: Various activities and investigations. For example:
   "Navigating by the Stars" activity – Exploration section. Students will demonstrate capability with data collection and analysis using their own astronomical data of Polaris (north star) and the time of sunset to determine approximately their latitude and longitude.

3. Students will demonstrate proficiency with using analyzed data to analyze models of nature (theories) and develop and test hypotheses that address real world problems.

   Assessments: Various activities and investigations. For example:
   "Navigating by the Stars" activity – Concept Development section. Students will use their data analysis to orient themselves on the earth and be able to communicate their location without reference to objects or landmarks.

4. Students will demonstrate proficiency with using scientific content and data analysis to recognize the limitations of the scientific process.

   Assessments: Various activities and investigations. For example:
   "Navigating by the Stars" activity – Reflections section. Students will include some error analysis to determine basic uncertainty in their data collection and analysis as applied to finding their location on the earth if they get lost. This will be guided by answering a set of questions.

Information Required for Creating Assessment Plan in Taskstream

Table #2	Course Outcome(s) Information
Course Outcome 1:	Students will demonstrate proficiency with the scientific content of Astronomy, including retention of terms, definitions and concepts.
Method to Measure Course Outcome	Direct - Exam
Details/ Description:	Assessments: Multiple Choice sections of 3 exams (See attached Test 1 as an example.)
Satisfactory Performance Standard (based on rubric):	Students score > 70% average on Multiple Choice sections of exams
Ideal Target (based on rubric):	70% of students score > 75% average on Multiple Choice sections of exams
Implementation Plan (timeline):	Each semester the course is taught; generally, once a year.
Key/Responsible Personnel:	Galen Hansen
Supporting Attachments: These attachments are to be placed immediately after the associated chart in the proposal.	*Attachment 1:* **Test 1 for example of Multiple Choice exam questions**

Outcome 1 Assessment Rubric

Multiple Choice sections of 3 Tests during the course.

Outcome 1 Goal: 70% of students achieve an average score > 75% correct answers

See Test 1 Multiple Choice section for example.

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SCIE 1199 Astronomy Test #1

I. TERMS and UNITS Multiple choice. (1 pt. each)

1. The average distance between the earth and the sun is one
(a) astronomical unit; (b) solar unit; (c) megameter; (d) parsec; (e) light year

2. The distance light travels in one year is one
(a) astronomical unit; (b) solar unit; (c) megameter; (d) parsec; (e) light year

3. The star nearest the earth is [(a) Polaris; (b) Vega; (c) Sirius (d) the Sun; (e) Proxima Centauri]

4. Polaris is called the north star because
(a) it is the brightest star in the sky as seen from earth
(b) it is the nearest star to the earth
(c) it is the star we see on the norther horizon from Fairmont, WV
(d) it is the star the earth's axis of rotation points to as seen from the northern hemisphere
(e) it is the star that crosses the celestial meridian at midnight.

5. One million in scientific notation is (a) 10^2; (b) 10^3; (c) 10^6; (d) 10^9; (e) 10^{12}

6. One AU is approximately 1.5×10^8 km. How many kilometers is Jupiter from the sun if Jupiter is 5 AU from the sun?
(a) 3.0×10^8; (b) 7.5×10^8; (c) 3.5×10^8; (d) 6.5×10^8; (e) 5.0×10^8

7. A scale on a map indicates that 1 cm = 200 km. If the actual distance between two cities is 1200 km, what is the scale distance between the two cities on the map?
(a) 6 cm; (b) 12 cm; (c) 20 cm (d) 0.17 cm (e) 24 cm

8. Clouds of lit-up gases in the galaxy are called
(a) nimbus; (b) stratoids; (c) dark matter; (d) nebuli; (e) bright spots

9. Material in between the stars of the galaxy is called
(a) dark matter; (b) nimbus; (c) interstellar medium; (d) solar wind; (e) stray matter

10. A constellation is defined by the IAU to be
(a) A collection of bright stars forming a specific pattern seen from earth
(b) A cluster of stars that look like a popcorn ball
(c) A token prize given to contest losers
(d) A place in the sky which the moon passes through
(e) An area of the sky with defined boundaries.

11. The imaginary model of a transparent globe upon which visible stars are superimposed;
(a) Celestial orb; (b) Terrestrial sphere; (c) Universal globe; (d) Crystal ball; (e) Celestial sphere

12. An asterism is defined by the IAU to be
(a) A collection of bright stars forming a specific pattern seen from earth
(b) A cluster of stars that look like a popcorn ball
(c) A token prize given to contest losers
(d) A place in the sky which the moon passes through
(e) An area of the sky with defined boundaries.

Match the following terms with their appropriate definitions below
(a) Celestial meridian; (b) Equatorial plane; (c) zenith; (d) horizonal plane; (e) celestial pole

13. The plane defined by the meeting of the sky and earth.
14. A point in the sky that remains motionless as the earth rotates, defined by the earth's rotational axis
15. The plane defined by the earth's equator, perpendicular to the earth's rotational axis
16. The position in the sky directly above an observer (straight up)
17. An imaginary line running North-South across the sky through an observer's zenith; the highest point of ascension for any celestial object as seen by an observer.

Match the definitions in 18-21 below with the following terms
(a) Zodiac; (b) vernal equinox; (c) autumnal equinox; (d) summer solstice; (e) winter solstice

18. The location in the sky where the apparent path of the sun and the celestial equator intersect at the beginning of spring (March 21); defines 0 hr. 00 min. right ascension

19. The location of the sun at its **southern**-most position in the sky; beginning of summer in the southern hemisphere).

20. The constellations on the ecliptic plane that the sun passes through during the year

21. Precession of the earth's axis causes this to pass through all twelve Zodiac constellations over a 26,000 year period.
(a) Summer solstice; (b) Sun; (c) Moon; (d) Orion; (e) north celestial pole

22. Which statement is **false**?
(a) The earth's axis continually points toward the north star even as the earth orbits the sun.
(b) The earth's axis tips back and forth as it moves around the sun, causing the seasons.
(c) The southern hemisphere begins spring as the northern hemisphere begins fall.
(d) The earth is closer to the sun when it is winter in the northern hemisphere.

23. The asterism whose front two stars (Dubhe and Merak) point to the north star is called the
[(A) Orion; (B) Taurus; (C) Little Dipper; (D) Big Dipper].

24. The asterism with three bright stars for a belt and bright nebula forming a sword is called
(A) Orion; (B) Taurus; (C) Little Dipper; (D) Big Dipper

25. What asterism is the Vernal Equinox found in?
(a) Orion; (b) Sagitarrius; (c) Pisces; (d) Gemini; (e) Pisces.

26. What asterism is good for location the celestial equator in the winter night sky?
(A) Orion; (B) Taurus; (C) Little Dipper; (D) Big Dipper; (E) Cassiopeia

27. It is summer in the **southern** hemisphere in January because
(a) The north pole is tipped towards the sun.
(b) The north pole is tipped away from the sun.
(c) The earth is closest to the sun.
(d) The sun gets hotter.

28. The earth's climate and weather is due to
(A) The rotation of the earth
(B) The changing of the sun's angle on the earth's surface as the earth orbits the sun.
(C) The changing distance between the earth and sun
(D) The sun warms the various regions of the earth differently as the earth rotates.

29. What is the angle between the earth's equator and the ecliptic plane?
(a) 39.5°; (b) 23.5°; (c) 50.5°; (d) 66.5°; (e) 5°

30. What is the name of the latitude at which one must stand to see the sun directly overhead at noon when the sun is at the Winter Solstice?
(a) Arctic Circle
(b) Antarctic Circle
(c) Tropic of Cancer
(d) Tropic of Capricorn

31. The arctic circle is defined as the latitude
a) 23.5° below the north pole;
b) 23.5° north of the equator;
c) 66.5° north of the equator;
d) both a) and b);

e) both a) and c)]

32. A scientific model by which one views and describes unseen aspects of nature based on real observations is called a/an
(a) law; (b) hypothesis; (c) predication; (d) theory; (e) hyperbola

33. A statement of facts that have been observed to never vary under certain conditions is called a
(A) law; (B) hypothesis; (C) predication; (D) theory; (E) hyperbola.

34. When making a decision, which aspect of decision-making relies the **least** on personal view?
(A). Realizing that a decision needs to be made.
(B) Figuring out what kinds of information are necessary for the decision
(C). Collecting information
(D). Analyzing the information to see which choice fits your needs the best.
(E). Observing whether the decision is good or bad.

Table #2	Course Outcome(s) Information
Course Outcome 2:	Students will demonstrate proficiency with data collection and observations using appropriate equipment and record-keeping during class and lab activities.
Method to Measure Course Outcome	Direct - Student Artifact
Details/ Description:	Successful participation in the data gathering and organizing sections of class/lab activities, for example: Day 8: "Navigating by the Stars" – Exploration section
Satisfactory Performance Standard (based on rubric):	35/50 pts. Students receive full credit if they: 1. (10 pts) Make and properly use a sextant; 2. (10 pts) Properly measure, record Polaris data needed to determine their local latitude; 3. (10 pts) Obtain and properly average the Polaris data of other students with theirs; 4. (10 pts) Properly measure Sunset data needed to determine their local longitude; 5. (10 pts) Obtain and properly average the Sunset data of other students with theirs;
Ideal Target (based on rubric):	80% of students score > 35/50 pts.
Implementation Plan (timeline):	Each semester the course is taught; generally, once a year.
Key/Responsible Personnel:	Galen Hansen
Supporting Attachments: These attachments are to be placed immediately after the associated chart in the proposal.	*Attachment 1:* **Navigating by the Stars Activity – Exploration** section *Attachment 2:* **HR Diagram & Stellar Life Cycles Investigation – HR Diagram section**

Outcome 2 Assessment Rubric

Outcome 2 Goal: 80% of students achieve an average score > 35/50 points

See "Navigating by the Stars" - Exploration section:

Exploration	10 pts	8 pts	6 pts	4 pts	2 pts
A. North Star A.1.	Student makes sextant and uses it correctly to draw accurate diagram of norther horizon & Polaris.	Student makes sextant, uses it to draw north horizon diagram with a few minor mistakes.	Student makes or borrows sextant, uses it to draw north horizon diagram with major mistakes.	Student makes or borrows sextant, draws a quick, very flawed diagram of the north horizon & Polaris.	Student copies and turns in someone else's drawing.
A.2-3.	Student uses sexton and helps partner to correctly to obtain angle of Polaris above N horizon.	Student uses sexton and helps partner to obtain angle of Polaris with some inaccuracy.	Student uses sextant and helps partner, each one's angle of Polaris is significantly inaccurate.	Student and partner uses sextant incorrectly, angles of Polaris are far from accurate.	Student and partner turns in someone else's measurements.
A.4-5.	Student obtains data from other students, correctly finds that averages of data.	Student obtains data, averages of data have some minor mistakes.	Student obtains data, averages of data have at least on major mistake.	Student obtains data, averages of data are make incorrectly with major flaws	Student uses someone else's averages.
B. Sunset	10 pts	8 pts	6 pts	4 pts	2 pts
B.1-2.	Student uses watch correctly to record date and time of sunset and draw accurate picture.	Student uses watch to obtain date and time of sunset and draw picture with some inaccuracy.	Student uses watch to inaccurately obtain date and time of sunset and draw picture with major flaws.	Student use of watch to obtain wrong date and time of sunset and fails to draw picture	Student and partner turns in someone else's measurements and drawing.
B.3-4.	Student obtains data from other students, correctly adjusts averages of data.	Student obtains data from other students, adjusts averages with minor mistakes.	Student obtains data from other students, adjust-ments of data have at least one major mistake.	Student obtains data from other students, averages of data are make incorrectly with major flaws	Student uses someone else's averages and adjustments.

Course Outcome 2

Day 8: Navigating by the Stars

Exploration – Data Collection 50 pts.

Pretend you are lost in the hills of West Virginia. You have with you a sextant (protractor with hanging string) and a watch set at Standard Universal Time (UST). With these two instruments you must figure out the latitude and longitude of your island.

A. North Star: Use your sextant to determine your latitude. (30 pts)

1. With a partner, go outside after dark on a clear night and find Polaris. Using your sextant with the flat edge up and the string hanging from the center of the circle of curvature of the rounded edge, sight along the flat edge and aim it at a position or stationary object in the distance directly below Polaris. While keeping the sides of the protractor aligned with the object, make the flat edge horizontal (keeping the sides vertical) by rotating the edge until the string crosses the curved portion of the protractor at exactly 90º. Note the exact position in the distance below Polaris that the protractor's flat edge is aimed at. This will define your horizon, as if you were looking out at the flat ocean from your island. Draw a picture of the northern horizon with Polaris above the horizon and objects directly below Polaris that are horizontal with your observation position.
2. Keeping the sides of the protractor lined up with the distant position, sight along the flat edge and rotate the sextant until the flat edge is aimed directly at Polaris. Note the angle at which the string crosses curved edge of the protractor. Record the string angle.

**Note that it is much easier to do this with another person.

3. Help your partner make the same measurement described in 1. – 2. and record their measured angle of Polaris above the north horizon.

4. Obtain the measured angles from at least 4 other people.

5. Find the average of all the recorded angles. This will be used to determine your latitude.

B. Sunset: Use your watch to determine your longitude (20 pts)

1. Go to a location where you can clearly observe the sun setting as low to the western horizon as possible, that is, without hitting a hill, tree or building first.

2. Measure the exact time (to the nearest minute) at which the sun disappears beneath the horizon. Record the time and the date of your observation.

3. Obtain the time and date of sunset from at least 4 other people.

SS1._____; SS2. _____; SS3. _____; SS4. _____; SS5. _____; SS6. _____

date._____; date. _____; date. _____; date. _____; date. _____; date. _____

4. Correct each time to Universal Time by adding 4 hours (before the end of Daylight Savings Time) or 5 hours (after the end of Daylight Savings Time).

US1._____; US2. _____; US3. _____; US4. _____; US5. _____; US6. _____

You will use these times and dates later to determine your longitude.

Table #2	Course Outcome(s) Information
Course Outcome 3:	Students will demonstrate proficiency with using models to analyze data, assess the validity of models of nature (theories) using analyzed data, develop and test hypotheses that address real world problems.
Method to Measure Course Outcome	Direct - Student Artifact
Details/ Description:	Successful participation in astronomy model-building and hypothesis testing sections of class/lab activities; for example: (a) "Navigating by the Stars" – Concept Development section
Satisfactory Performance Standard (based on rubric):	30/40 pts. Students receive full credit if they: 1. (10 pts) proper draw models of the earth-view motion of celestial objects; 2. (10 pts) properly draw celestial view of earth with latitude and longitude lines and connect Polaris data with latitude; 3. (10 pts) properly connect sunset data with longitude; 4. (10 pts) correctly calculate longitude and ascertain uncertainty.
Ideal Target (based on rubric):	80% of students score > 30/40 pts.
Implementation Plan (timeline):	Each semester the course is taught; generally, once a year.
Key/Responsible Personnel:	Galen Hansen
Supporting Attachments: These attachments are to be placed immediately after the associated chart in the proposal.	*Attachment 1:* **Navigating by the Stars Activity – see Concept Development** section *Attachment 2:* **HR Diagram & Stellar Life Cycles Investigation – see Stellar Life Cycles section**

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Assessment Rubric for Outcome 3

Outcome 3 Goal: 80% of students achieve an average score > 30/40 points

See "Navigating by the Stars" – Concept Development section:

Concept Dev.	10 pts	8 pts	6 pts	4 pts	2 pts
A. Models of Celestial Motion A.1-5.	All 5 drawings of celestial motion are correctly drawn	1 of 5 drawing of celestial motion has major mistakes or 2 of 5 drawings have minor mistakes	2 of 5 drawings of celestial motion have major errors or 1 of 5 drawings has major errors while 2 of 5 have minor mistakes or 4 of 5 drawings have minor mistakes.	3 of 5 drawings of celestial motion have major errors or 2 of 5 drawings have major errors while 2 of 5 have minor mistakes	Student have provided some effort but 4 of 5 drawing have major errors.
B. Latitude B.1-3.	Both drawings of Earth are correctly drawn & Latitude correctly calculate.	1 drawing or calculation has significant error minor error.	2 drawings or 1 drawing and a calculation has significant errors	Both drawings and calculations have significant errors	Student turns in poor drawings and incorrect calculations
C. Longitude C.1-2.	Both drawings of Earth are correctly drawn & Latitude correctly calculate.	Student obtains data, averages of data have some minor mistakes.	Student obtains data, averages of data have at least on major mistake.	Student obtains data, averages of data are make incorrectly with major flaws	Student uses someone else's averages.
C. Longitude C.3.	Student correctly calculates longitude and uncertainty	Student makes minors error in calculations with minor coaching	Student makes a couple of significant errors and requires significant coaching.	Student makes major errors with unsatisfactory effort.	Students makes major errors and leaves most undone

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Course Outcome 3

Day 8: Navigating by the Stars

Concept Development – Celestial Models & Data Collection 40 pts.

A. The regular, repeating motions of the sun and stars through the sky allow us to use them to figure out our position on earth.

1. 2 pts. Draw a northern-view picture of the sky showing the North Celestial Pole as seen from Fairmont, WV and the celestial meridian. Also include three circumpolar stars and their circular path around the north celestial pole.

2. 2 pts. Draw a southern-view picture of the view of the sky from Fairmont, WV, including the Celestial Equation (arching from E horizon to W horizon) and the celestial meridian.

3. 2 pts. On your picture of (b), draw the sun rising at 6:00 am on September 22. Draw the path of the sun across the sky during the day, parallel with celestial equator, until it sets in the west. Draw the sun setting on September 22 at 6:00 pm.

4. 2 pts. On your picture of (b), draw the sun rising at 5:15 am on December 22. Draw the path of the sun across the sky during the day, parallel with celestial equator, until it sets in the west. Draw the sun setting on June 22 at 6:00 pm.

5. 2 pts. Look at the earth-view maps of the sky centered on the Celestial Equator. What bright star in the northern Celestial Hemisphere will cross the celestial meridian about half an hour after the sun sets on September 22? Draw the star's daily path through the sky parallel with the Celestial Equator until it reaches the Celestial Meridian. In what direction will a person standing in Fairmont, WV need to look to see this star half an hour after sunset?

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B. Latitude

1. 3 pts. Make side-view drawing of the earth

   a) Draw circle representing the Earth. Draw a long vertical line through the center of the earth representing the axis of rotation. Extend the line beyond the top and bottom of the earth. Label the top of the earth North and the bottom of the earth South.

   b) Draw the equator as a horizontal diameter line through the center of the earth perpendicular to the vertical axis of rotation.

2. 3 pts. Zenith and Horizon

   c) Draw a line from the center of the earth to a spot on the right-side surface of the earth lying 30° north of the equator such that the line makes a 30° angle with the equatorial plane. The spot on the surface has a latitude of 30° N.

   d) Draw a straight diameter line through the center of the earth that is exactly perpendicular (90°) to the 30° line you drew in B1c. above. The line will extend from a spot on the left-side surface 60° north of the equatorial plane, to a spot on the right-side surface 60° south of the equatorial plane. This line is parallel to the horizon (tangent line) of a person standing at a latitude of 30° N latitude.

3. 4 pts. Angle of Polaris

   a) Comparing your side-view drawing of the earth (just above) with your view of Polaris and the northern sky from Fairmont, WV (Concept Development A1. above), you can see that the angle measured between Polaris and the North horizon is your latitude on earth.

   b) Include on your picture of Polaris the angle you measured between Polaris and the northern horizon. What is your latitude as determined by your data collection and analysis?

   Latitude: _____

   Accepted Latitude of Fairmont, WV _____

   c) Find the % difference between your measured latitude and the accepted latitude:

   (Measured – Accepted)/(Accepted x 100% = _____

C. Longitude.

1. 4 pts. Connecting Time with Longitude

a) Comparing your southern-view picture (A.2. above) with the celestial-view drawings of the earth found in your astronomy textbook and provide in class, determine as precisely as you can the celestial angle between the celestial median of your Exploration observation location and the Celestial Prime Meridian passing through the Vernal Equinox.

b) Convert the celestial angle of (a) to time in in hours and minutes, using the Celestial Prime Meridian as 0 hours, 0 minutes. Remember: there are 360° around the earth and the earth rotates every 24 hours, so 1 hour equates to 15°, and 4 minutes is 1°.

c) Estimate the time uncertainty (# of minutes) in the celestial angle time.

2. 6 pts. Analyze the Data

a) From each time of sunset of your Exploration Data that you recorded earlier (your own or someone else's) subtract 1 hour from each time which was recorded before daylight savings time ended (before the first Sunday after November 1).

b) Determine the number of days, #D, that each recorded time of sunset was taken after September 22.

#D1._____; #D2. _____; #D3. _____; #D4. _____; #D5. _____; #D6. _____

c) Determine the number of minutes away from the Autumnal Equinox by multiplying each #D by the ratio 76min/90 day

(#D x 76/90 = #M

#M1._____; #M2. _____; #M3. _____; #M4. _____; #M5. _____; #M6. _____

d) From each time of sunset (adjusted for daylight savings time), add its #M (time from vernal equinox). Then subtract 16 minutes (time zone correction)

TS = SS + #M – 16.

TS1._____; TS2. _____; TS3. _____; TS4. _____; TS5. _____; TS6. _____

Find the average adjusted time of sunset by adding all the TS's and dividing by the number of TS's added together. For example, if I had five TS's,

TS_{ave} = (TS1 + TS2 + TS3 + TS4 + TS5)/5

3. 10 pts. Find Your Longitude

   a) Convert you time in hours and minutes to decimal form by dividing the minutes by 60 minutes. For example, 4:52 pm = 4 + 52/60 hours = 5.87 hours pm.

   b) Multiply your TS_{ave} by the ratio of $360^{o}/24hr$

      Longitude = TS_{ave} hours x $360^{o}/24hr$ = _____

      Accepted Longitude of Fairmont, WV _____

   c) Find the % difference between your measured longitude and the accepted longitude:

      (Measured – Accepted)/(Accepted x 100% = _____

Table #2	Course Outcome(s) Information
Course Outcome 4:	Students will demonstrate proficiency with scientific content and data analysis to recognize the limitations of the scientific process.
Method to Measure Course Outcome	Direct - Student Artifact
Details/ Description:	Successful participation in the uncertainty analysis of at least two class/lab activities, for example: (a) "Navigating by the Stars" – Reflection section
Satisfactory Performance Standard (based on rubric):	7/10 pts. Students receive full credit if they can fully and correctly answer questions in the Reflections section of the Navigating activity describing the uncertainty and scientific limitations in modeling nature and in establishing their position on earth as tested by determining their location and orienting themselves on the ground.
Ideal Target (based on rubric):	70% of students score > 8/10 pts.
Implementation Plan (timeline):	Each semester the course is taught; generally, once a year.
Key/Responsible Personnel:	Galen Hansen
Supporting Attachments: These attachments are to be placed immediately after the associated chart in the proposal.	*Attachment 1:* **Navigating by the Stars Activity – see Reflection** section *Attachment 2:* Questions to be developed for post-HR Diagram investigation reflection

Assessment Rubric for Outcome 4

Outcome 4 Goal: 70% of students achieve an average score > =8/10 points

See "Navigating by the Stars" – Reflection section:

Reflections	10 pts	8 pts	6 pts	4 pts	2 pts
Questions 1-5.	Student provides clear and detailed answers for all 5 reflection questions.	Student provides short answers lacking detail for 2 of 5 questions.	Student provides short answers lacking detail for 4 of 5 questions.	Student fails to answer 1 questions and provides short answers lacking detail for other questions.	Student provides short answers lacking detail for only 2 questions, nothing for other 3.

Course Outcome 3 **Day 8: Navigating by the Stars** **Reflection 10 pts.**	

Reflections on the Scientific Process Applied to this Activity (10 points)

1. (2 points) Which of the experimental results obtained in this lab can be compared with accepted results?

There are accepted experimental results for the angle between Polaris and the northern horizon, the universal time at which the sun sets on the horizon on a particular date, the latitude and longitude of Fairmont, WV. The implication is that precision is a better gauge than accuracy of the success of the experiment.

2. (2 points) What can you conclude about the fact that some experimental results can be compared with accepted values and some cannot be?

The fact that some data can be compared with accepted values and some not implies that some parameters change randomly in nature, while others are constant and/or very repetitive. One's location can be considered random, and there may not be accepted times for the actual setting of the sun because of the hills and other local conditions.

3. (2 points) How confident are you that the values you found for latitude and longitude are accurate, that is, close to accepted values? What determines the error of your results, that is, the difference between your results and the accepted values?

Location and conditions for observing the angle between Polaris and the northern horizon, or the time of sunset; the precision of one's instruments of measurement; one's ability to reproduce the measurements, i.e. the precision with which measurements can be made.

4. (2 points) In this experiment, is it possible to distinguish between uncertainty in the values of latitude and longitude that is due to either

a. limitations in the methods you used to measure these numbers or

b. limitations in the assumptions we make (the models we use) to describe friction?

In other words, can we determine from this experiment whether the equations and corrections made under the conditions of the experiment are correct? That is, can we determine how good our scientific model of nature is?

Since the large uncertainty in the measurements of latitude and longitude can be attributed to quality of the data taking with crude instruments by mere observation, it is probably not
possible to distinguish between that uncertainty and the validity of the model.

5. (2 extra points) How could the experiment be improved to obtain more precise and accurate results?

In order to test whether the model is correct, better methods of measuring angles and of determining the horizon are needed to determine latitude to a fraction of a degree. Also, natural phenomenon more precise than the setting of the sun are required to determine longitude to a fraction of a degree.