### Key Hawaiian Values:

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### Key Science Content Standards:

- E.S.8.11 – technologies used in astronomy
- E.S.8.12 – different theories of the formation of the universe

### Learning Styles:

- Left & Right Brain
- Visual
- Auditory
- Kinesthetic

### Term: **NĀ HŌKŪ / STARS UNIT OVERVIEW**

**Content:** Spirituality & Science Theories of Universe

*NOTE: lessons may take longer than 1 long class period*

### Timeline: **2-4 weeks**

#### Date: / M T W Th F _____ Min.

<table>
<thead>
<tr>
<th>Lesson Topic/Activity</th>
<th>Performance Indicators</th>
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<tbody>
<tr>
<td><strong>1. Night Sky</strong></td>
<td>Informal - Assessment of participation; Formal – pre-test answers attempted</td>
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<td><strong>2. Navigating &amp; Astrolabes</strong></td>
<td>Formal – correct answers on sheets &amp; functional model</td>
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<td><strong>3. Constellations</strong></td>
<td>Informal – listening effort; Formal – functional model</td>
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<td><strong>4. Star Beliefs</strong></td>
<td>Informal – timeline participation; Formal – full/correct answers to reading</td>
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<tr>
<td><strong>5. Theories about Space</strong></td>
<td>Informal – participation; Formal – correct answers to questions</td>
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#### Date: / M T W Th F _____ Min.

### Global Learning Objectives:

- #3 Complex Thinker
- #4 Quality Producer
- #5 Effective Communicator

### Recommended extensions to lessons:

- **Field Trip** to planetarium, observatory, traditional Hawaiian site for star navigation
- **Guest Speakers** who studies stars as part of their jobs &/or interest, esp. in Hawaiian astronomy
- **Lessons** on the Sun, the Moon, and our Solar System
- **Video** go to [http://pvs.hawaii.org/bibliographies.html](http://pvs.hawaii.org/bibliographies.html) for several choices, some of which are available at state libraries

### Culminating Project: Post-Test & Presentation, Debate, Essay, Diorama or Poster on “My Exploration on Space” (can be spiritual or scientific)

### Overall Assessment:

- Informal – 50% participation in class activities
- Formal – 50% accuracy of information on all student work products
## Index to HCPS II, NHEC Guidelines & Unit Lessons

### NHEC Learner Guidelines (adapted)

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<tr>
<th>Topic</th>
<th>Standard</th>
<th>Description</th>
<th>Coverage</th>
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<tr>
<td>Hawaiian Cultural Knowledge</td>
<td>HC.9.0</td>
<td>Utilize the Hawaiian language to explain scientific concepts</td>
<td>All lessons</td>
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<tr>
<td>Hawaiian Cultural Knowledge</td>
<td>HC.9.1</td>
<td>Compare Hawaiian ways of learning and knowing with other cultural knowledge systems</td>
<td>All lessons</td>
</tr>
<tr>
<td>Hawaiian Cultural Knowledge</td>
<td>HC.9.2</td>
<td>Demonstrate knowledge of Hawaiian history</td>
<td>Lessons 1.1-3 &amp; ...</td>
</tr>
<tr>
<td>Hawaiian Cultural Knowledge</td>
<td>HC.9.3</td>
<td>Make connections between Hawaiian cultural knowledge, diverse indigenous perspectives and the larger world community</td>
<td>Lessons 1.1-3 &amp; ...</td>
</tr>
</tbody>
</table>

### DOE Content Standards (2005)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Standard</th>
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</tr>
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<tbody>
<tr>
<td>The Universe</td>
<td>ES.8.11</td>
<td>Describe technologies used to collect information about the universe</td>
<td>Lesson 1.2, 2.3</td>
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<td>The Universe</td>
<td>ES.8.12</td>
<td>Explain different theories concerning the formation of the universe</td>
<td>Lesson 1.1, 2.2-2.3</td>
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<td>Earth in the Solar System</td>
<td>ES.8.2</td>
<td>OPTIONAL EXTENSION to UNIT: Describe how to estimate geologic time</td>
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<td>Earth in the Solar System</td>
<td>ES.8.3</td>
<td>OPTIONAL EXTENSION to UNIT: Explain possible origins and evolution of the solar system</td>
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<td>Forces that Shape the Earth</td>
<td>ES.8.9</td>
<td>OPTIONAL EXTENSION to UNIT: Describe the major internal and external sources of energy on Earth</td>
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<tr>
<td>The Universe</td>
<td>ES.8.10</td>
<td>OPTIONAL EXTENSION to UNIT: Describe the physical and nuclear dynamics involved in the life cycle of a star</td>
<td></td>
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Nā Hōkū/Stars Unit: Teacher Notes

1.1.a Night Sky Activities

Purpose: to inspire interest in astronomy/navigation lessons and learn basic constellations and mathematics used to chart a course at sea

Prep: 1st have students CUT UP SOME STUFF! (template for large orbs is below & can be made with glitter, glue & colored foil - make 15 copies!):

- 3 blue/white glittering orbs (will be labeled: Navigator’s Triangle - Hawaiiki/Alpha Cygni/ Deneb; Keoe/Alpha Lyrae/Vega; Humu/Alpha Aquilae/Altair. (These are in the constellation Huinakolu in Maui’s Fishhook/Scorpius)
- 5 blue/white & 2 red/yellow glittering orbs (will be labeled: Makali’i/Pleiades)
- 2 white/yellow glittering orbs (will be labeled: Hōkū-pa’a/Polaris/North Star and Sun)
- 1 white/green glittering orb (will be labeled: A’a/Sirius)
- 2 shiny foil orbs (will be labeled: Venus and Moon)
- 8 points of the compass labeled: North, South, East West (for 4 corners of the room) & Ho’olua (NW wall), Ko’olau (NE), Malanai (SE) & Kona (SW) ... wall diagram is below

2nd MAKE THE DESKS LOOK LIKE THE HŌKULE‘A
(i.e. move seats into double-hull configuration in middle of room) like this

3rd STICK STUFF ON THE WALLS to show students where to place above hōkū, etc. (see guide below)

Intro Discussion Points: (see more notes below)

- How did we get here? Talk story about modes of transport used by Hawai‘i kama‘aina & 2nd/3rd generation residents (by jet), previous generations (by ship) and ancient generations (sailing canoe). Ask students to compare feats of NASA shuttles going to space now & Polynesians going across unknown Pacific then & now

- How did we get back? Talk story about how Hawaiians today and long ago knew which way to go while at sea and the many ways to navigate (modern, ancient). Discuss why people took/take these voyages (survival, culture). In order, ask students to share info from their handout (see below) about: the North Star, the Navigator’s Triangle, other Constellations, Planets, the Moon, Sun, latitude & longitude, & other tools (ocean swells, landmarks, seamarks, sealife, clouds, weather & climate).
1.1.a-d Teacher's Notes: Night Sky for the Classroom

**DIRECTIONS:** Place nā hōkū (stars), hōkū hele (planets), mahina (moon) & lā (sun) on the walls of the classroom as shown in the diagram below.

*(NW or Hoʻolu Classroom Wall)*

Navigator's Triangle in the constellation Huinakolu in Maui's Fishhook/Scorpius

- Humu/Alpha Aquilae/Altair
- Hawaiki/Alpha Cygni/Deneb
- Keoe/Alpha Lyrae/Vega
- Hōkū-pa’a/Polaris/North Star
- Makali‘i/Pleiades
- Ka O Makali‘i/orion’s Belt
- A’a/Sirius

*(SW or Kona Classroom Wall)*

Mahina/Moon

*(NE)*

*(SE or Malanai Classroom Wall)*

*(Sailing canoe style seating)*

Science in Hawai‘i: Nā Hana Ma Ka Ahupua’a – A Culturally Responsive Curriculum Project
1.1.a-d Teacher’s Notes: ‘Night Sky’ Class Discussion

One option to lead this introductory activity on celestial navigation is to place these heavenly bodies on the walls and “talk story” about them in this order, using the student handouts to encourage student responses:

Note: this is the configuration of the winter sky after sunset, about the time of the beginning of Makahiki in Hawai‘i. The summer sky looks very different!

1. Put 3 stars of the Navigator’s Triangle on the NW wall & ask students to read aloud about them or …
   
   **ASK:** Which of these 3 stars’ light left its source about the time you were born? (Answer: Humu)
   Which of these 3 stars’ light left its source about the time Jesus was born? (Hawaiki)
   Which of these stars used to be the North Star? How old would you be when it will be again? (Keoe, 14,000+)

   Now, put the Hōkū-pa’a in the North corner and …
   
   **ASK:** Do stars move? (Yes, change seasonally & Big Bang theory says they move away from center of the universe very slowly; and No, Earth moves fast so stars appear to move fast around us, but are stationary relative to each other & the Earth as all are moving away from the center of the universe with the rest of the galaxies)
   Does the Hōkū-pa’a move? (same answers above, but from Earth’s northern hemisphere it appears not to move at all) … Compare this star to your fingerpoint on the bottom of a spinning basketball … all other stars appear to rotate around the North Star – not around the Earth, which seems stationary to us!

2. Put Makali‘i/Pleiades on the NE wall and
   
   **ASK:** Why was Makali‘i so important to ancient Hawaiians? (Ans: beginning of Makahiki, new year, time of peace)
   Why was it so important to astronomers elsewhere? (Ans: it is very close to us, so was easier to study & compare to other things in space)
   How could it still be important now? (answers will vary: can also be used to find Hōkū-pa’a, still good to study)

3. Put Ka Hei-Hei O Nā Keiki /Orion’s Belt and A’a/Sirius on the SE wall and …
   
   **ASK:** Which of these stars is the brightest? How bright is it? (Sirius, 50 times brighter than Ka Lā)
   How can we use Ka Hei-Hei O Nā Keiki to find A’a? (the ‘belt’ called Kao Makali‘i points to A’a)

   Continued ….
Why do these constellations have so many different names & ancient myths? Why are there no new myths? (answers will vary: to help us identify and remember them all...Stars are less important to most of us nowadays)

4. Put Ka Lā/the Sun on the SE wall & Venus and the Moon on the SW wall and discuss hōkū hele (the wandering stars kāhuna identified long ago).

**ASK:** What happens to all these stars when the Sun rises in the east? (they disappear) What about Venus & the moon? (both are only 2 things in space that can stay visible in daylight under the right conditions)
Why do you think Hawaiians called planets 'wandering stars'? (ans: they moved around more) What allows Venus & other planets to appear to wander? (ans: they rotate around the sun, not the North Star, and they are very close, so we see their movements more easily from Earth)
How can we tell Hōkūloa/Venus and A‘a/Sirius apart if that’s all we can see at night? (ans: planets don’t twinkle, they shine; stars twinkle because winds in the universe are believed to interfere with their light ... that’s why our ‘night sky’ orbs are not all made of glitter!)

**OPTIONAL ACTIVITY** - See "Star Watching With Your Hands" (student handout)

5. To help students to measure with their hand practice with Venus (note, in the winter sky it will be setting in the west). Before you move Venus down the wall, it may appear above your middle finger, or along it (check that it is positioned high enough to appear above the palm). Now have a student move the orb down, as if it is setting. When students measure again, they may see it relative to their thumb joint. The point is to have students use their hand and eye to track a planet’s or star’s progress over time. This shows how voyagers could tell time at night and identify their stars.

**ASK:** If it were too cloudy to see Hōkū-pa‘a, how could watching Hōkūloa/Venus help a voyager at sea? (Answers will vary: The constellations are only slightly different each night, so the more hōkū and hōkū hele you know, the more ways you have to make sure you’re on course... also, knowing the seasons helps voyagers know where stars should be).

6. To help students calibrate degrees with their fist practice with Hōkū-pa‘a and any other celestial orb.

**ASK:** How can we calibrate degrees with our fist to tell which bright light is Hōkūloa/Venus & which is A‘a/Sirius? (Answer: Hōkūloa will move more degrees away from Hōkū-pa‘a faster than A‘a.)
ANSWER KEY DOCUMENTS (2 PAGES) MISSING HERE:

This content will be accessible by log in soon. Please check back! All answer keys are available in the binder and on disk (to be delivered to state libraries, plus DOE & charter schools in Sept-06) or e-mail lisa.galloway@hawaii.edu.
1.3.a Teacher’s Notes: Mapping Nā Hōkū/Stars

Discuss p.1 of “Mapping Nā Hōkū” with students & help them find where the constellations given are:

Ausxa Minor (Little Dipper) with Hōkū-pa’a (North Star) as red dot on top of handle (it’s upside-down)

Ausxa Major (Big Bear) with Nā Hiku (Big Dipper) at center

Canis Major constellation with A’a (Sirius/Alpha Canis Majoris) at the top (belt of Orion on red line points down to it)

Students can circle, trace or re-draw the constellations on another sheet.

Continue to read aloud on p.2 and help students place Hōkū-pa’a in like this in a straight line above the right edge of the dipper.

It is best if you make a model of the planisphere described on pgs.3-4 and show it to students before doing it. Alternately, if you have computer access for all, the class can explore the internet for the projects given below &/or find similar projects to these (there’s loads of ’em!):

- http://domeofthesky.com/st9h20N.html;
- http://www.pvshedawaii.com/navigation/hawaiiancompass.htm;
- http://www.lhs.berkeley.edu/starclock/skywheel.html;
- http://www.lhs.berkeley.edu/starclock/starclockprintout.html)
Stars Unit: Teacher Notes 2.1-2.3

2.1 Students can read Star Beliefs handout alone or aloud in a group then respond to the reading questions on page 3 to consider careers in space science and their beliefs and questions. Students can either be asked to research the careers given, or be given the handout listing career details.

2.2 Download the Cosmic Calendar lesson and student handouts at www.astrosociety.org/education/astro/act2/cosmic.html to guide the class through an activity based on Carl Sagan’s timeline of events in the universe scaled down to one Earth year.

OPTIONAL: You may also want to compare &/or integrate with a timeline of events in astrophysics that have led to our current understanding of the universe (some of which is explained in the lesson below). Get the Astrophysic Discoveries Timeline at:
http://en.wikipedia.org/wiki/Timeline_of_knowledge_about_galaxies%2C_clusters_of_galaxies%2C_and_large-scale_structure

2.3.a Together as a class or in small groups that either present to the class later or to each other in jigsaw grouping, students can read and discuss the handout Important Theories in Space Science. Other options include having small groups create a visual representation of their theory to help peers remember it (i.e. drawings, skit, mnemonic poem/anagram, etc).

2.3.b The handout How Old is the Universe? can be read aloud for group discussion. The balloon activity, Make Your Own Expanding Universe, can be done by each student or in pairs. The original version of this activity & a student chart to fill in with follow-up questions is also included here: see Expansion of the Universe Activity sheet.

Additional info for teachers on this topic is available at:

http://www.voyagesthroughtime.org/updates/ ... which give the four lines of Evidence supporting the age of the universe as:

1. the age of the chemical elements,
2. the age of the oldest star clusters,
3. the age of the oldest white dwarfs, and
4. the temperature of the cosmic background radiation.
http://education.aas.org/publications/AncientUniverseWeb.pdf ... which has a 20 page PDF booklet & good graphics explaining how astronomers know the age of universe

http://map.gsfc.nasa.gov/m_uni/uni_101age.html ... which has more info on how old the universe is

http://en.wikipedia.org/wiki/Astrophysics has TIMELINES in SPACE

www.astrosociety.org/education/astro/act2/cosmic.html has activities for lots of space science

RECOMMENDED FURTHER AREAS OF STUDY FOR THIS UNIT ARE:

• A field trip to a local observatory, planetarium, site where ancient Hawaiians observed stars (often in bowl of water) to teach navigation, create the lunar calendar, etc.
• A guest speaker who uses the stars to navigate &/or do his/her job (i.e. fishermen, astronomers, traditional farmers)
• Further lessons & activities focused on the Sun, the Moon, and our Solar System