Unit Planning Document

Unit Title: Reasons for Seasons

Curriculum Objectives: Tasmanian Curriculum: Science. Standard 3 (stages 7-9).
Strand: Science as a body of knowledge--Earth and space. Main Idea: Earth and space have characteristic features and patterns of activity.
Strand: Scientific Communication. Main Idea: Scientists need to communicate information in a variety of ways.

Duration (lessons, time, location):
Three Lessons over the course of a week.
Lesson 1: Build Earth-Sun model.
- Classroom (1 hour)

Lesson 2: Build and analyse Shadow Boards.
- Classroom (20 minutes in beginning of day)
- Outside (up to six times during sunny day--approximately 5 minutes each to collect data)
- Classroom (20 minutes at the end of day)

Lesson 3: The Seasons (analyse Earth-Sun model and final presentation)
- Classroom (1.5 hours)

Context:
This unit plan is for the combined Year Level 5/6 class of South Arm Primary, which has 114 enrollments (51 girls and 63 boys), and an above average Index of Community Socio-Educational Advantage (ICSEA) of 1030 with a 26%, 20%, 21%, 33% distribution of students. (Source: http://myschool.edu.au).

Prior Learning (Tasmanian Curriculum):
Science-Standard 2--Science as a body of knowledge--Earth and Space
- Identifying the Sun as the main source of heat and light energy for all things on Earth.
- Observing times for sunrise and sunset at different times of year.
- Demonstrating the relationship between the Sun and Earth e.g. using role-play to show how day and night occur.
- Identifying and describing how the apparent position of the Sun changes in the sky during the course of the day and discussing the effect this has on temperature.

Math-Standard 2--Space, Standard 3--Measurement,
- Discussing and demonstrating of turns (e.g. full/half turn) as an introduction to angle.
- Providing opportunities to quantify attributes such as ... angle ... and temperature for the purpose of comparing and/or ordering and communicating.

Unit Planning Document	
Key Understandings: •Seasonal climate is affected by the changes in the incident angle of sunlight and the daily hours of sunlight due to the tilt of the Earth as it orbits the Sun. •Scientists use specific language to describe Earth and space phenomena, for example, "orbit" for the path of the Earth around the Sun, and "hemisphere" for the northern or southern half of the earth, divided at the equator.	**Outcomes:** •Students construct an Earth-Sun model to identify and study the effects of the Sun on Earth over the course of a year. •Students design and build a "shadow board" to analyse and describe the relative path of the Sun in the sky. •Students interpret the principles of the interplay between the constant tilt of the Earth's orbit and seasonal sunlight to summarise the accepted scientific principles of annual climatic variations in the southern and northern hemispheres.

Formal Assessment Strategies:

•Worksheet--the worksheet is designed to reinforce student understanding for the final presentation.
•Final Presentation--the final presentation is a performance-based summative assessment. Students will be provided with a choice of oral, written (descriptive and/or sketch), or group role play to describe the reason for seasons.

Assessment Index
Appendix A--Formal assessment guidelines.
Appendix B--Informal assessment guidelines (informal assessments specified in Stage 2.3 and Stage 3.2).
Appendix C--Grading Tool for summarising evidence.
Appendix D--Assessed Worksheet.
Appendix E--Rubric for Final Presentation.

Unit Stage	Objective	Sequence of Activity	Resources	Integration
Stage 1.1	Engage (12 minutes)	•Demonstration of Earth-Sun scale. Sun represented by 6.7cm sphere (tennis ball), Earth represented by 0.6mm sphere (ballpoint pen tip). One student holds tennis ball in corner of room, others guess where Earth should be in relative scale (7.25 meters away). •Diagnostic Assessment: Brainstorm why there are seasons; write hypotheses on board (assess basic concepts, e.g. Earth orbits around Sun, and alternate conceptions for the explanation of seasons). •Five minute video on Earth-Sun orbit with visual explanation of seasons.	Tennis ball Ballpoint pen tip Tape measure Video: http://www.deuce4.net/web/EarthSun.swf	
Stage 1.2	Construct non-scale model of Earth-Sun system (35 minutes)	•In groups of 5, students construct Earth-Sun model. The model features a wire 'egg-holder' loop for the model so the Earth's axis can always be oriented in the north/south direction. The size of the loop (combined with toothpicks in the poles) aids in maintaining constant 23.5 degree angle tilt during 'orbit'.	Earth-Sun model design and materials (Appendix F)	
Stage 1.3	Initial discussion of model and constant tilt of the Earth (12 minutes)	•Identify the actual north-south line in classroom. Ensure that as model earth orbits the model sun that the model earth's axis is always aligned with true N-S. •Scaffold understanding and informally assess each group's ability to predict and place model in position of summer and of winter. •Note: the southern hemisphere can be "up" with this model (South Pole points toward southern part of room).	Earth-Sun model	

Unit Stage	Objective	Sequence of Activity	Resources	Integration
Stage 2.1	Design and construction of "Shadow Board" (20 minutes)	•The shadow board is a transportable board (on heavy cardboard) with a glued vertical dowel and compass. Teacher scaffolds design variables (e.g. cardboard size, dowel height and position on board). •Depending on level of students ability to intuitively 'guesstimate' shadows and angles, teacher provides dimensions and/or models the Shadow Board design.	Shadow Board design and materials (Appendix F) Sun angle calculator: http://www.ga.gov.au/geodesy/astro/smpos.jsp	
Stage 2.2	Collecting data on Shadow Board on cloud-free day (6 sessions, 5 minutes each)	•Shadow board is taken outside 4-6 times during the day. Student aligns board to north with compass and ensures board is flat with shared spirit level, then marks shadow length and position. •Students also record temperature subjectively and writes note on board at each point (i.e. cold in morning, warming during day).	Shadow Board	
Stage 2.3	Analysis of Shadow Board (20 minutes at end of day)	•In the classroom, students analyse shadow board at end of day. Ask students to imagine Sun position for each point. Seek understanding that rising Sun angle (shortest shadow) correlates to warming day. Ask why? Discuss angle of incidence/energy effects and atmospheric effects. ***Formatively assess student understanding:*** •By oral, written, or kinaesthetically means, student can describe daily path of the Sun, and can synthesise Sun path for a different time of the year. •Student links higher Sun angle to warming temperatures. •If time permits, introduce Stellarium, a program with excellent visualisation of changing Sun paths.	Shadow Board Informal Assessment Guidelines (Appendix B) http://www.stellarium.org/	Math-Standard 3: Using data obtained from the Shadow Board, create two math lessons: *Measuring angles using formal measures (e.g. protractor) and comparing angles. *Present data in tables, bar graphs and line graphs (chart shadow length vs. time).

Unit Stage	Objective	Sequence of Activity	Resources	Integration
Stage 3.1	Engage (10 minutes)	•Group activity: "Kinaesthetic Tilt"--students gather in large circle around a "sun" in the center and everyone tilts 23.5 degrees to the south. Imagine southern and northern hemispheres as upper/lower torsos; teacher questions where higher noon shadows in southern hemisphere would occur.	Idea source: http://www.spacescience.org	
Stage 3.2	Analysis of Earth-Sun model (30 minutes)	•Review seasonal positions of model with southern hemisphere up and axis aligned toward the south (identify four seasons: tilt is toward the Sun in summer, and away from Sun in winter, and neutral during equinoxes--but always tilted to southern part of room). •With their group's model, students place shortened 0.5 cm toothpick in Hobart and analyse shadows on Earth model in darkened room in summer and winter (see Appendix B for images of actual model). •With each group, teacher questions, scaffolds and links understanding of Sun angles, shadows, greater warmth with higher Sun angle, and Earth tilt. ***Formatively assess student understanding:*** •Students can accurately position model in various seasonal orientations.	Earth-Sun model Informal Assessment Guidelines (Appendix B)	Society Standard 3--Identity, relationships and culture: Indigenous perspectives of the six seasons in Melbourne and Kakadu. http://home.vicnet.net.au/~herring/seasons.htm http://www.environment.gov.au/parks/kakadu/nature-science/seasons.html http://www.bom.gov.au/iwk/climate_culture/Indig_seasons.shtml Key undestanding: The concept of four seasons is linked to the scientific principles of two equinoxes and two solstices, but that there are other (e.g. Indigenous) ways to describe annual seasonal variations.
Stage 3.3	•Worksheet and Reflection (25 minutes) •Final Assessment (35 minutes)	•***Worksheet*** (10 minutes quiet time). •Peer review of worksheet, teacher summarises key learning concepts with whole class (15 minutes). •Announce presentation. Provide break (i.e. recess). •***Summative assessment--final presentations:*** either oral, written (descriptive and/or sketch), or group role play (25 minutes with 10 minute preparation time).	•Assessment Guidelines •Grading Tools •Worksheet •Rubric (Appendix A,C,D,E)	Ali's unit on weather can link to this unit's understandings.

Appendix A: Formal Assessment Guidelines

Formal assessment for this unit comprises of a graded worksheet, and a performance based evaluation of the final presentation based on a grading rubric.

Prior to initiating the formal assessments, summarise the key points of the lesson:
•The Earth orbits around the Sun.
•The Earth maintains a constant 23.5 degree tilt with poles tilted north/south.
•The tilt affects the seasonal sunlight reaching each hemisphere:
(a)In summer, the days are longer and the Sun is more overhead.
(b)In winter the days are shorter and the Sun is lower in the sky.
•Varying amounts of sunlight (duration and incidence angle) affect the seasonal climate.

Worksheet (Formative)
The worksheet is formative in nature, designed to aid identification of reasons for seasonal climate.
•Question 1 is to verify cognitive construction of Sun angles through the use of shadows. The correct answer has two components: the shadow at noon should be drawn shorter and to the right of the shown shadow. Students who have correctly analysed their Shadow Boards will be able to predict the noon shadow using the provided information.
•Question 2 describes the seasonal Sun paths, and reinforces through visual means that in summer there are both more hours of daylight, and that the angle of incidence of the Sun's rays is higher.
•Question 3 is a cloze activity with significant clues, and results in the accepted scientific explanation of seasons.

Performance Based Assessment of Presentation (Summative)
To initiate provide students with a choice of explaining the reasons for seasons:
•An individual oral presentation to the class using the Earth-Sun model.
•A description in their science journals comprising of a written paragraph and sketches describing the phenomena of seasons.
•In groups of 4, a role-play performance to communicate their comprehension of the seasons.

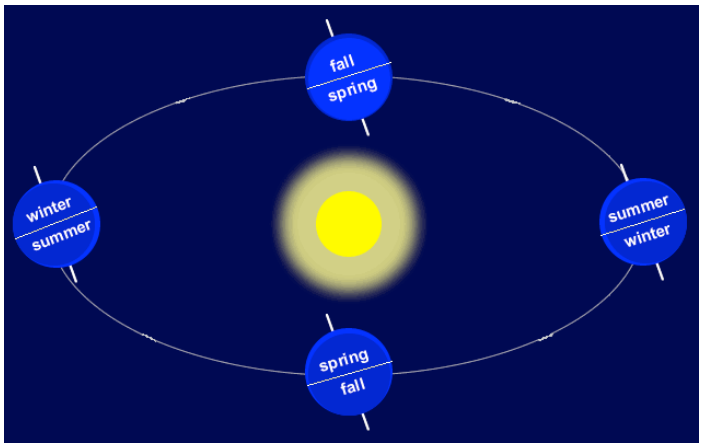
Explain to students that the description/presentation should encompass a one-year timespan. Separate the class into groups/areas based on their choice. Students working on a written description in their science journals should be provided with the most quiet space and work individually. Students working on the oral presentation can discuss with each other in a quiet voice. and encouraged to use the Earth-Sun model. Each group of students working on the role-play should have an isolated area to collaborate on their performance. If there is not a even multiple of four students per group, encourage remaining students to choose another option.

Informed by the kinaesthetic role play in the lesson (Stage 3.1), students choosing the role-play might represent each student as one of the solstices and equinoxes. Ensure observation of all students by asking each student which season they represent, which direction their head is tilting, and which part of their torso represents the northern and southern hemisphere, and to describe the solar aspects.

Grading of the presentation (whether oral, written, or role-play) is based on questioning using the Grading Rubric in Appendix E. Appendix C is the Grading Tool for summary evidence collection.

Appendix B: Informal Assessment Guidelines

To accurately assess this unit, the teacher scientifically understands the reasons for Earth's seasons.



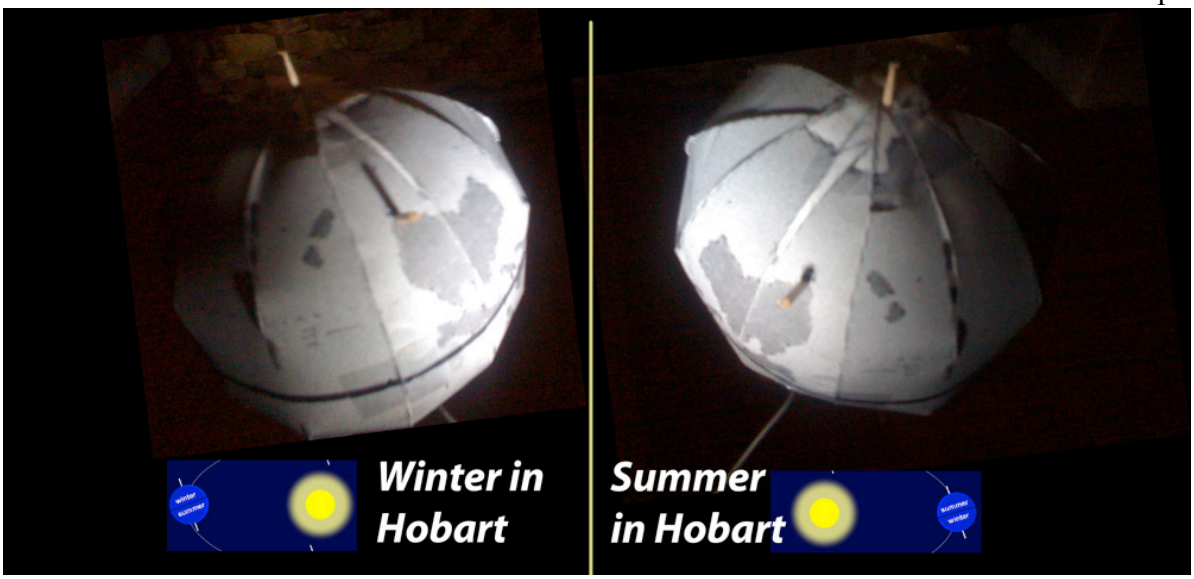
This lesson is better served in Australia with the South Pole pointing "up" and the tilt pointing toward the south. Remind students that the Earth-Sun model is not to the correct scale, and represents the constant tilt of the Earth as it annually orbits around the Sun. It is helpful to use the correct cardinal directions in the classroom by labelling the North, South, East and West walls of the room.

There are two common alternate conceptions about the seasons, which both involve proximity to the Sun. The most common alternate conception is that that the Sun is closer in summer and farther away in winter. Alternatively, the student might understand that the Earth has a tilt, but believes the effect of tilt is to bring a hemisphere closer or farther from the Sun and the resulting change in distance affects the temperature.

Notes on informal assessments:

•Stage 2.3: By oral, written, or kinaesthetically means, student can describe daily path of the Sun. The student should center the path to the north, describe path from east to west, and describe the maximum height of the Sun at a azimuth angle no greater than 66 degrees in Hobart (the absolute value of latitude--42.85^{o} in Hobart plus 23.45^{o}). A common misconception is that the Sun is overhead at noon, which only occurs in the tropics.
Advanced students can able to predict and describe the Sun path in different seasons.

•Stage 3.2 Students can accurately position model in various seasonal orientations, and visualise the shadows (see image below, these would be on opposite ends of the "orbit"). Ensure students maintain the alignment of the Earth model's axis with the true north-south axis of the classroom, and scaffold/link the differences in shadows to differences in insolation based on direct experience.



Appendix C: Grading Tool--Teacher's Assessment Evidence Record

Name	Assessment				Comments
	WS 1	WS 2	WS 3	Presentation	
Amy					
Brad					
Carol					
...					

The Unit Plan's Stage 2.3 and 3.2 informal assessments of can also be included in comments.

Worksheet Assessments (Formative):
1. Predicting shadow.
2. Analysis of apparent Sun paths (winter and summer).
3. Cloze activity to correctly explain reasons for annual seasons.

Performance Assessment (Summative):
Assessment of either an oral, written description with sketches, or group role play scientifically describing the change of seasons.

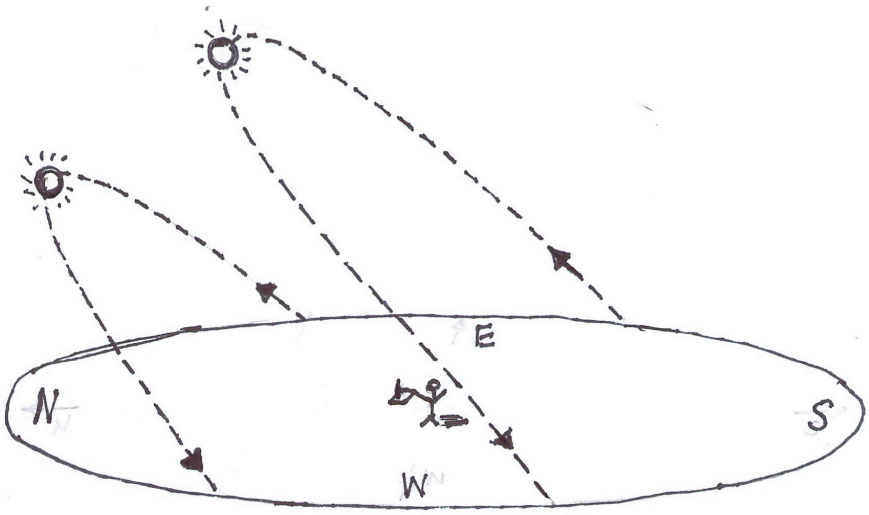
The final grade is determined primarily by final presentation and informed by the worksheet and informal assessments. Students with Level 3 comprehension of each of the rubric criterion (Appendix E) are marked as proficient at Tasmanian Curriculum Stage 10. Students with an Level 1 on each of the criterion will be marked at Stage 6. Students with Level 2 on each of the rubrics are proficient at Stage 8. Further divisions on proficient/ advanced are based on review of rubric levels and worksheet results.

Appendix D: Student Worksheet

Reasons for Seasons Worksheet Name:_____

1. The diagram below shows the shadow of a flagpole in the morning. Sketch the shadow a few hours later at noon. (Hint: first determine the general direction of north).

2, The diagram below shows the apparent Sun paths for winter and summer. Mark each path as either "Winter Sun Path", or "Summer Sun Path". Why is it warmer is summer?



3. Fill in the blanks:

In SUMMER, the southern hemisphere tilts _____ (toward/away from) the Sun due to the tilt of the Earth, and the Sun appears _____(higher/lower) in the sky. This means there will be more daylight hours, and the intensity of the Sun is greater because the Sun is generally higher in the sky. These two effects cause _____ (more/less) warming of the southern hemisphere and thus the seasonal temperatures will be _____(warmer/cooler).

In WINTER, the southern hemisphere tilts _____ (toward/away from) the Sun due to the tilt of the Earth, and the Sun appears _____(higher/lower) in the sky. This means there will be less daylight hours, and the intensity of the Sun is less because the Sun is generally lower in the sky. These two effects cause _____ (more/less) warming of the southern hemisphere and thus the seasonal temperatures will be _____(warmer/cooler).

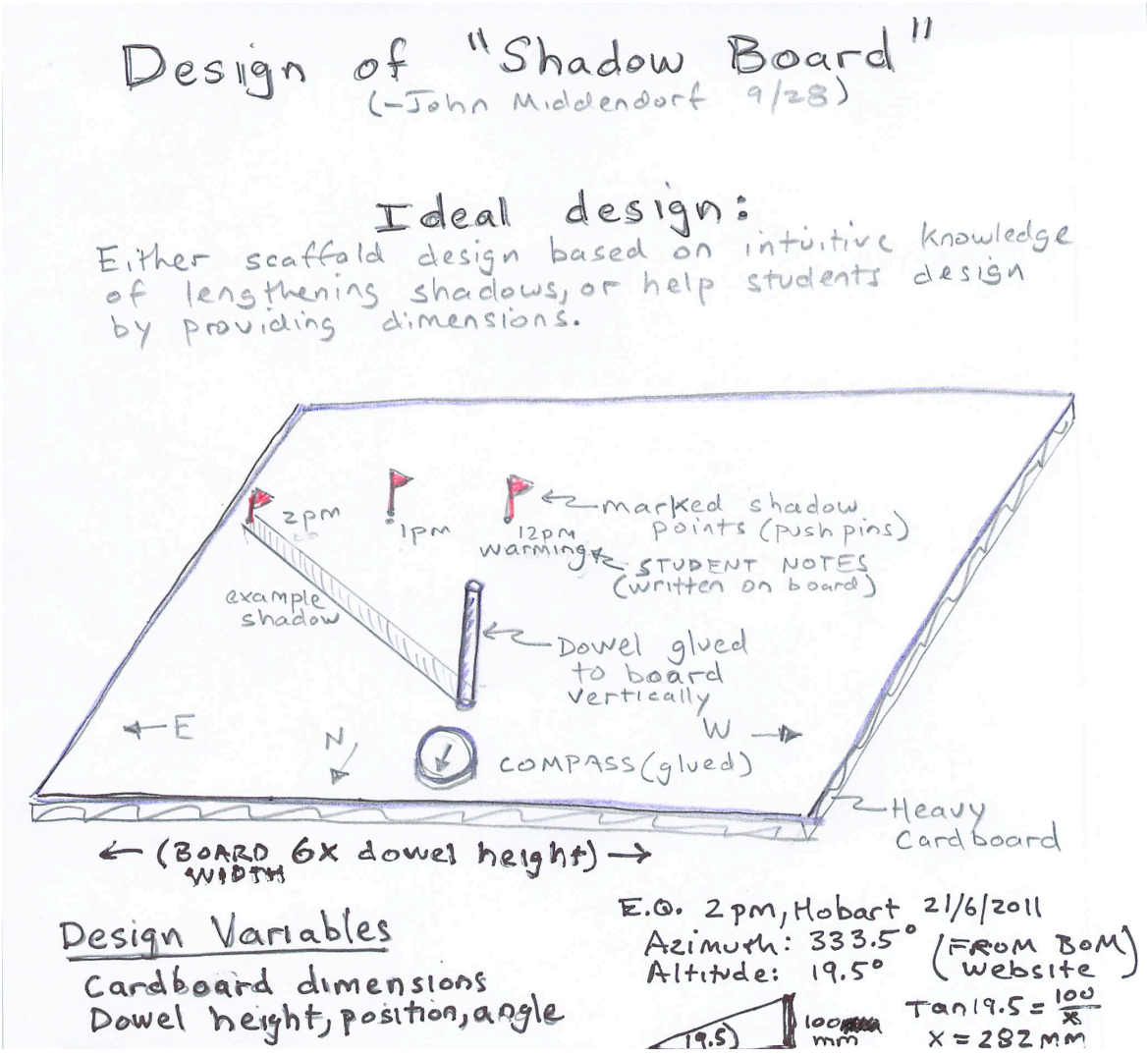
Appendix E: Rubric for Final Presentation

Criterion	Level 3	Level 2	Level 1
Earth-Sun Path	*summarises additional key points about Earth's path: the Earth orbits the Sun in a elliptical orbit but that the elliptical variation is not the primary explanation for seasons.	*illustrates that Earth annually orbits around the Sun.	*retains alternate conceptions of the Earth-Sun orbit.
Tilt of Earth	*describes constant 23.5 degree tilt of the Earth as it orbits the sun, and indicates correct north/ south orientation.	*expresses the tilt of the Earth.	*limited understanding of Earth's tilt.
Hemispheric effects	*interprets the hemispheric solar effects of tilt (daylight hours and incident angle of sunlight), and summarises the effects on seasonal climate.	*compares and contrasts the tilt between winter and summer, recognising respectively that the poles will be either pointing away from or toward the Sun (solstices).	*unable to distinguish solar seasonal differences in northern and southern hemispheres.
Scientific Communication	*purposefully, succinctly, and scientifically summarises seasonal phenomena by accurately referring to relevant evidence and uses the correct scientific language.	*refers to scientific principles and evidence to describe seasonal phenomena.	*employs unscientific language and misinterprets evidence.

Appendix F: Resources

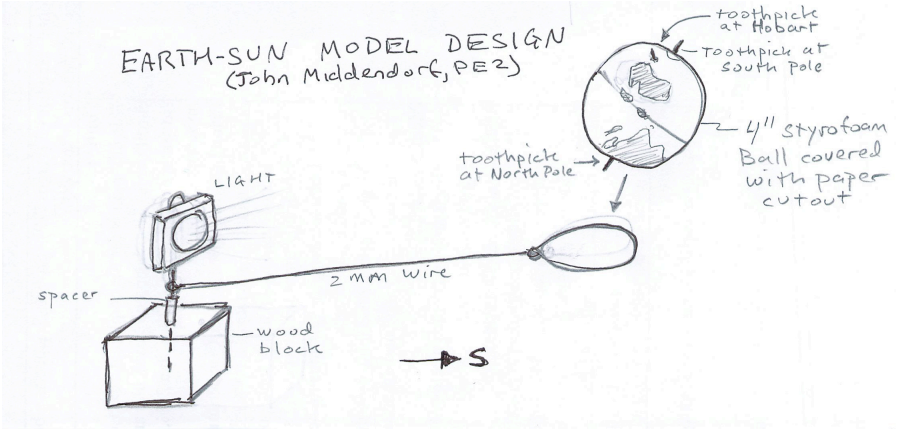
Earth Sun Scale demonstration:
6.7cm tennis ball.
0.6mm ballpoint pen tip (dissect from pen and glue to end of toothpick).
7.25m measuring tape.

Shadow Boards (per student):
600mm x 300mm heavy cardboard (from old boxes)
100mm thin dowel
Inexpensive compass
Markers and glue
Several shared spirit levels (board must be level for all measurements)

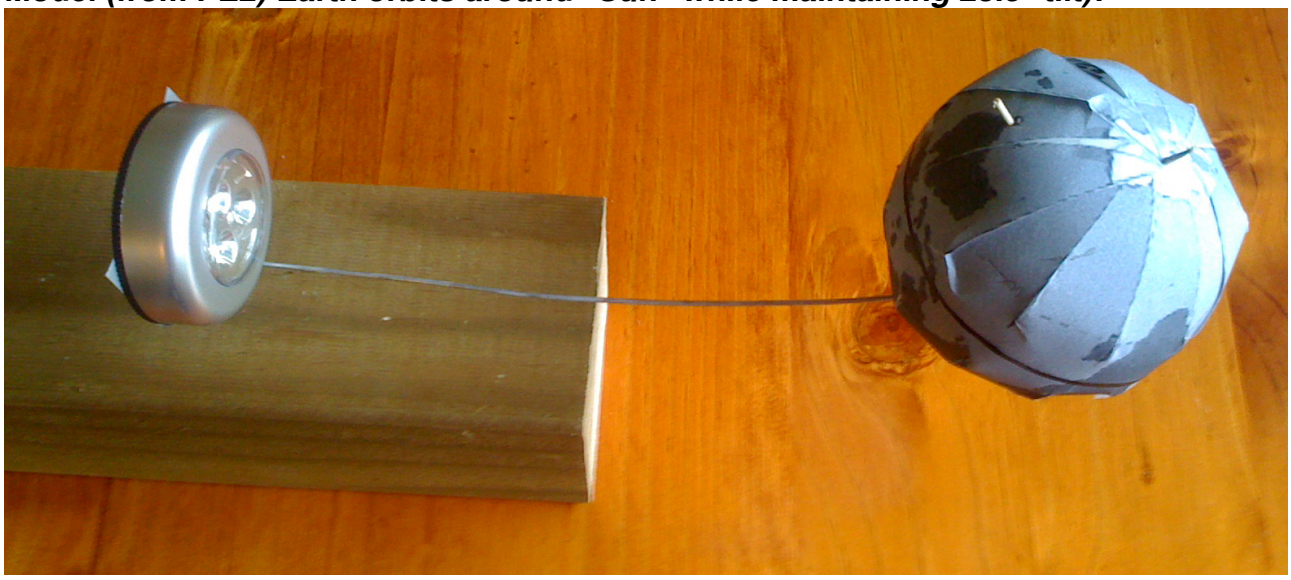


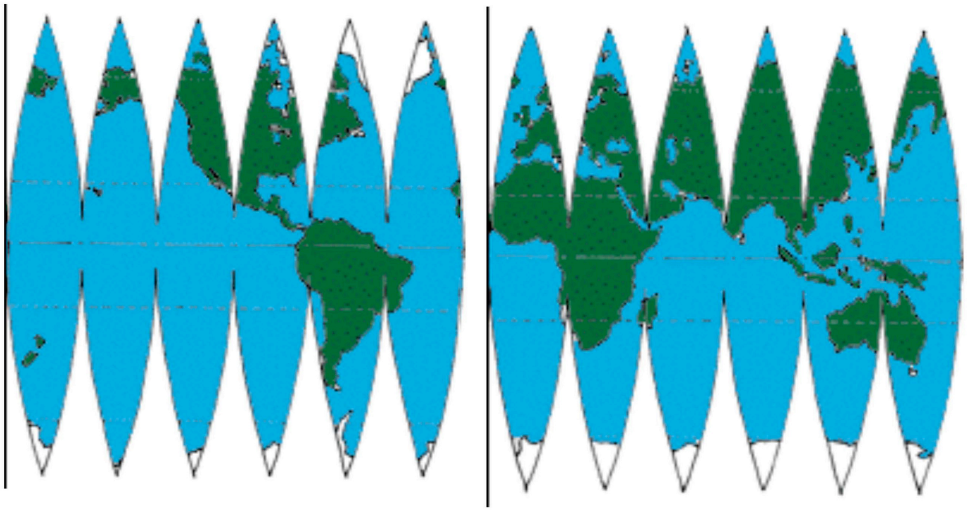
Earth-Sun Model (per group):

4" Styrofoam Balls (Spotlight)
Inexpensive LED lights (3/$5 at KD)
Globe Cutouts (below)
Toothpicks for poles and for "shadow"
2mm wire and needle nose pliers.
Spacers (Ramset 5mm)
Wood Block (4"x4"x4")



Model (from PE2) Earth orbits around "Sun" while maintaining 23.5º tilt):





Globe Cutouts

Steps for students:
1.Cut out.
2.Mark North and South poles on sphere with marker; line up and paste cutouts onto sphere.
3.Draw line with marker around equator.
4.Place toothpicks in North and South Poles.

Cutout source: http://www.gma.org/surfing/imaging/globe.html (rescale for 4" styrofoam spheres).